Some Effects of Weapons Technology on Air Apportionment

A Monograph

by

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14. ABSTRACT

Air apportionment is the joint force commander?s tool for weighting his main and supporting efforts within the air operations supporting his campaign. It complements the targeting process by specifying how much effort is to be expended within each category. Consequently, it comprises much of the operational art of airpower employment at the theater level. Past studies have centered on the doctrinal differences between the services on how airpower should be apportioned; that is, on the apportionment decision. This monograph focuses on the apportionment process, not its results. Discussion is restricted to the apportionment of combat airpower. The monograph explores the impact of advances in weapons technology on the apportionment process and asks if these advances necessitate changes in the apportionment process. It traces the evolution of the apportionment process through the Korean War, Vietnam War, and Operation Desert Storm. Current joint and U.S. Air Force doctrine on the subject are then discussed, and its utility assessed by using Operation Allied Force as a case study. Three characteristics of an ideal apportionment process are postulated based on the historic and doctrinal review. Apportionment should be complete and thus able to identify, apportion, and utilize each relevant capability of available joint or multinational air forces. An apportionment process should also be efficient. That is, is should waste little time, facilitate quick accomplishment of its tasks, and lend itself to automation for incorporation into battle management software suites. Finally, it should be transparent. This characteristic views apportionment as a communication tool and requires the entire process to be visible and understandable to all actors. Two trends?advances in weapons systems, and advances in weapons?are studied in detail. Friction points between each area and the apportionment process are explored and several solutions are proposed for each problem. These proposals are distilled into six different options. The strengths and weaknesses of each option are explored in light of the criteria, with a heavy emphasis on a systems viewpoint. The monograph concludes that some changes in the joint apportionment process are warranted and makes four recommendations. First, commanders should phrase their apportion decisions using weight of effort. Second, commanders should apportion their forces based on theater or component objectives or tasks. Third, consideration should be given to experimentation to assess how practical and useful it would be to apportion by weapon for certain weapons. Finally, battle management software should be modified to facilitate extracting data relevant to apportionment. Apportionment is critical to integration and synchronization of joint operations. Apportionment is already a complex process, and the advances in weapons and weapons technology presented in this monograph all complicate it further. The challenges are significant now and will get worse. Changes need to be initiated; command and control systems must grow at the same rate as the weapons and systems they manage. The risks are costly inefficiencies and perhaps even mission failure.

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ABSTRACT

SOME EFFECTS OF WEAPONS TECHNOLOGY ON AIR APPORTIONMENT by Major R. Christopher Stockton, USAF, 45 pages.

Air apportionment is the joint force commander's tool for weighting his main and supporting efforts within the air operations supporting his campaign. It complements the targeting process by specifying how much effort is to be expended within each category. Consequently, it comprises much of the operational art of airpower employment at the theater level. Past studies have centered on the doctrinal differences between the services on *how* airpower should be apportioned; that is, on the apportionment decision. This monograph focuses on the apportionment *process*, not its results. Discussion is restricted to the apportionment of combat airpower.

The monograph explores the impact of advances in weapons technology on the apportionment process and asks if these advances necessitate changes in the apportionment process. It traces the evolution of the apportionment process through the Korean War, Vietnam War, and Operation Desert Storm. Current joint and U.S. Air Force doctrine on the subject are then discussed, and its utility assessed by using Operation Allied Force as a case study.

Three characteristics of an ideal apportionment process are postulated based on the historic and doctrinal review. Apportionment should be *complete* and thus able to identify, apportion, and utilize each relevant capability of available joint or multinational air forces. An apportionment process should also be *efficient*. That is, is should waste little time, facilitate quick accomplishment of its tasks, and lend itself to automation for incorporation into battle management software suites. Finally, it should be *transparent*. This characteristic views apportionment as a communication tool and requires the entire process to be visible and understandable to all actors.

Two trends—advances in weapons systems, and advances in weapons—are studied in detail. Friction points between each area and the apportionment process are explored and several solutions are proposed for each problem. These proposals are distilled into six different options. The strengths and weaknesses of each option are explored in light of the criteria, with a heavy emphasis on a systems viewpoint.

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Apportionment is critical to integration and synchronization of joint operations. Apportionment is already a complex process, and the advances in weapons and weapons technology presented in this monograph all complicate it further. The challenges are significant now and will get worse. Changes need to be initiated; command and control systems must grow at the same rate as the weapons and systems they manage. The risks are costly inefficiencies and perhaps even mission failure.

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List of Abbreviations

AF	Air Force
AGM	Air to Ground Missile
AI	Air Interdiction
ATACMS	Army Tactical Missile System
ATO	Air Tasking Order
AWACS	Airborne Warning and Control System
CA	Counter Air
CALCM	Conventional Air Launched Cruise Missile
CAOC	Combined Air Operations Center
CAS	Close Air Support
CENTCOM	Central Command
CFACC	Combined Forces Air Component Commander
CINC	Commander In Chief
CINCPAC	Commander In Chief, Pacific
COMAFFOR	Commander, Air Force Forces
COMUSMACV	Commander, United States Military Assistance Command, Vietnam
DCA	Defensive Counter Air
FAC	Forward Air Contorller
FRY	Former Republic Of Yugoslavia
GAT	Guidance, Apportionment, And Targeting
GBU	Guided Bomb Unit
GPS	Global Positioning System
ISR	Intelligence, Surveillance, Reconnaissance
JAOC	Joint Air Operations Center
JAOP	Joint Air Operations Plan
JASSM	Joint Air to Surface Standoff Missile
JCS	Joint Chiefs Of Staff
JDAM	Joint Direct Attack Munition
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander
JFLCC	Joint Force Land Component Commander
JIPTL	Joint Integrated Prioritized Target List
JP	Joint Publication
JSCP	Joint Strategic Capabilities Plan
JSOW	Joint Stand Off Weapon
JTCB	Joint Targeting Coordination Board
JTF	Joint Task Force
LGB	Laser Guided Bomb
MAGTF	Marine Air/Ground Task Force
NATO	North Atlantic Treaty Organization
NCA	National Command Authorities
OCA	Offensive Counter Air
PGM	Precision Guided Munition
SA	Strategic Attack

SAC	Strategic Air Command
SACEUR	Supreme Allied Commander, Europe
SEAD	Suppression Of Enemy Air Defenses
SECDEF	Secretary Of Defense
SLAM	Standoff Land Attack Missile
TACON	Tactical Control
TBMCS	Theater Battle Management Core Systems
TLAM	Tomahawk Land Attack Missile
UN	United Nations
VTC	Video Teleconference

INTRODUCTION

Demand for airpower typically exceeds supply. Since airpower is extremely versatile and can perform a wide variety of roles, the commander must divide air resources among several competing requirements. That process is called apportionment. The output of the apportionment process is easily related to anyone familiar with ground combat: it is the Joint Force Commander's (JFC's) way of identifying his main and supporting efforts to the Joint Force Air Component Commander (JFACC) and his planning staff.

Advances in the areas of weapons and weapons systems necessitate modification of the U.S. joint air apportionment process. The current air apportionment process described in joint doctrine is rooted in World War II; it has remained virtually unchanged since Operation Desert Storm. During that same period, however, the context, planning processes and weapons of war have substantially evolved. The primary force behind these changes is technology, and apportionment has not kept up.

The current paradigm for waging aerial warfare described in joint and Air Force doctrine relies heavily on the concept of "centralized control, decentralized execution."[1] The Air Tasking Order (ATO) is the cornerstone of "centralized control." The ATO process is very linear and sequential. Consequently, the end result of a slow or inefficient apportionment process can be a delayed or inefficient plan—neither of which is acceptable in today's time- and resource-constrained environment. Thus, a poor apportionment process can result in an inferior plan. Systemically, therefore, even slight improvements have the potential to reap large operational benefits.

Significant now, this issue threatens to become even more important in the future. Continued advances in weapons, coupled with the lower priority upgrading of battle management systems, promise only to widen the disparity between requirements and capabilities.

Relatively little attention has been paid to apportionment in either doctrinal or professional publications. Past studies have centered on the doctrinal differences between the services on *how* airpower should be apportioned; that is, on the apportionment <u>decision</u>. This monograph instead focuses on the apportionment process, not its results or the subsequent effects airpower generates (or fails to generate) as a consequence.

This monograph explores the historical roots of the current air apportionment process described in joint and Air Force doctrine. The doctrinal and historical reviews assist in developing characteristics of an "ideal" apportionment process. These characteristics provide the criteria against which current processes may be compared. Next, several specific advances in weapons technology are introduced, and their effects on air apportionment explored. Scrutiny of each issue through the lens of the criteria helps identify problems and shortcomings, and suggests changes or areas of exploration where answers might be found.

THE BASICS: APPORTIONMENT 101

What is apportionment?

The term apportionment may be used in several contexts. In its most basic and rudimentary form it means distribution of limited resources among competing requirements. In the context of strategic planning, the Joint Strategic Capabilities Plan (JSCP) "provid[es] strategic guidance, list[s] the situations for which plans are necessary, and apportion[s] **forces** to the combatant commanders for planning."[2] Joint Publication (JP) 4-0, D*octrine for Logistic Support of Joint Operations*, stresses the importance of carefully apportioning **resources**: failure to systematically apportion resources can result in the "senior commander's loss of control over the logistic system."[3] Finally, at the operational level, a Joint Force Commander typically apportions airpower assets, due to their versatility, flexibility, and theater-wide application.[4] Joint doctrine labels this latter process "air apportionment" and defines it as "the determination and assignment of the total expected effort by percentage and/or priority that should be devoted to the various air operations and/or geographic areas for a given period of time."[5] JP 3-56.1, *Command and Control of Joint Air Operations*, provides amplification: "Air apportionment allows the JFC to ensure the weight of the joint air effort is consistent with campaign phases and objectives."[6] Apportionment is thus the JFC's primary way of designating his main and supporting efforts in the joint air campaign.[7]

To limit its scope this monograph considers only apportionment of *combat* airpower, which E. West Anderson, a student at the U.S. Air Force's School of Advanced Airpower Studies, defined in his thesis as "any form of airpower employed in direct conflict functions..."[8] Apportionment of such combat support assets as airlift, reconnaissance, and tankers is not included. To be explicit: the joint definition of air apportionment (provided above) is used; to avoid cumbersome repetition, the term will shortened to merely *apportionment*.

More vocabulary

There are other words that quickly intrude on any discussion dealing with apportionment. Unless carefully defined and used they can hopelessly muddy the water, because the differences in their meanings often appear too trivial or too subtle to matter, or the meanings change with context. First, *apportionment* often appears in the company of allocation. At the operational level *allocation* refers to the "translation of the air apportionment decision into total numbers of sorties by aircraft type available for each operation or task."[9] Thus, allocation turns percentages (or level of effort, or whatever other measure the JFC uses to express his apportionment decision) into actual numbers of aircraft and sorties. According to JP 3-0, allocation is the JFACC's responsibility.[10]

Finally, at the cusp between operational and tactical use of airpower, and generally pertaining to close air support (CAS), the word *distribution* is used. Distribution is the process—conducted by the Joint Force Land Component Commander (JFLCC)—of dedicating allocated CAS sorties to his subordinate commanders to use in support of their schemes of maneuver. These blocks of sorties may in turn be *sub-distributed* to lower echelons. Each term has a very precise and differentiable meaning. This monograph focuses on apportionment of combat airpower.

Why is apportionment important?

Much of the "operational art" of airpower employment involves apportionment, and it is important for a number of reasons. It guides the JFACC, serves as an inter-component coordination tool, and provides concrete metrics against which campaign progress may be measured. As mentioned above, apportionment is a tool the JFC uses to weight his main and supporting efforts within each phase of the joint campaign. Often, a significant shift in apportionment signals airmen of the need to transition to another phase in the air campaign. Presently, nearly all of the debate surrounding airpower centers on targeting: deciding which targets to strike. That focus is too narrow. It neglects the equally important decisions involved in specifying the level of effort to be expended on each type of target (called a target set), or on accomplishing each objective. Level of effort is not the same as priority. A high priority objective (such as "destroy enemy ability to manufacture chemical weapons") may only require a small level of effort due to the small number of chemical agent manufacturing facilities.[11] Focussing on targeting ignores the two primary constraints of the real world: limited resources and limited time. Broadening one's view to include issues of apportionment captures much of the artistic challenge faced by operational airpower.

In addition to providing guidance to the JFACC and his staff, the apportionment decision serves as a coordination tool between the functional components. It allows other component commanders to see how much of the overall air effort will be devoted to supporting their objectives or concepts of operations. This coordination facilitates parallel planning efforts and increases the degree of integration of each component's efforts.

Finally, the apportionment decision should provide concrete standards against which campaign progress can be compared. This feedback is important for two reasons. First, it allows realistic, fact-based assessment of the plan and permits its adjustment to reflect battlefield realities as opposed to the situation anticipated while planning. Second, and equally importantly, the apportionment decision facilitates rapid feedback to all actors about the degree to which the JFACC's utilization of joint airpower conforms to the commander's direction. Personalities and perceptions matter; this very important function can foster an environment of interservice trust and cooperation rather than the distrust and antagonism that has characterized some joint operations in the past.[12]

Clarity and simplicity in expression of the apportionment decision enhance each of the roles apportionment plays. Unfortunately, such precision is difficult to attain. The joint definition alludes to several of the options, allowing apportionment "by percentage and/or priority" grouped by "the various air operations and/or geographic areas." In fact, these reflect only two of the three choices a commander must make in his effort to most precisely convey his intent. These choices are captured in Figure 1. One must decide what to apportion, what groups to parse those resources into, and how best to measure the size of each group. Several answers are possible for each question (the lists below each are representative, not comprehensive) and there are thus a number of ways to express an apportionment decision. Each has its strengths and weaknesses. The exploration of how commanders have expressed their decisions in the past will bring these to light.

Some measure of **something** is to be dedicated to **some purpose** .

Some measure	something	some purpose
•Priority •Weight (H,M,L) •Percent	•Bombing sorties •ATO lines •Sortie Generation capability	•Geography •Effect •Msn type •Objective/task •Target Set

Figure 1: Challenges to Clarity

Apportionment in context: the ATO process

Apportionment does not happen in a vacuum. Rather, the apportionment process is part of a larger system or process: the air tasking cycle. This six-step cycle, pictured below in Figure 2, is described in great detail in JP 3-56.1. It shows that JFC guidance is translated into targeting decisions, which are reflected in the ATO. The Combat Operations Division within the Joint Air

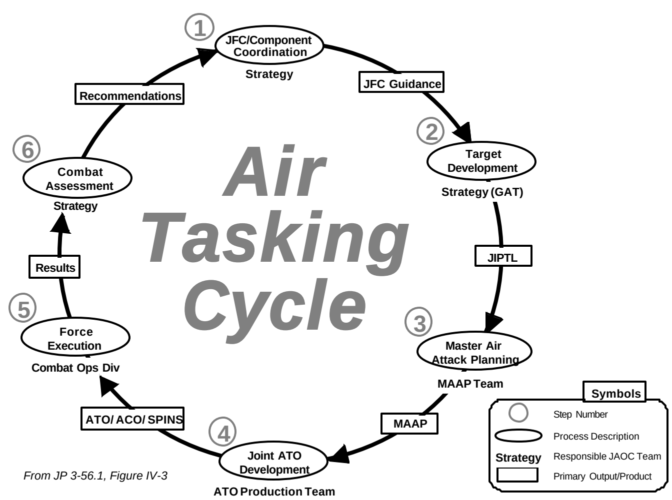

Figure 2: Joint Air Tasking Cycle

Operations Center (JAOC) executes this daily plan. The results are assessed by the Strategy Division, which folds any recommendations into subsequent ATOs. The context within which the daily ATO is built is the Joint Aerospace Operations Plan (JAOP)—the JFACC's subordinate plan that details his operations supporting the JFC's campaign. Whereas the ATO focuses on a specific twenty-four-hour period, the JAOP spans the entire campaign. The JAOP contains broad apportionment recommendations usually grouped by phase. The apportionment decisions used to build each ATO reflect the JAOP recommendations updated to reflect battlefield realities that cannot be anticipated with any precision during planning. These decisions embody more current JFC guidance than those contained in the JAOP.

In one sense, the apportionment process lies within the ATO process. When viewed chronologically, the apportionment process requires a relatively small fraction of the time required to generate and execute an ATO. Thus, the apportionment process—and the entire targeting process, as well—may be visualized as small wheels turning inside the larger ATO cycle. This view can be misleading. The phrase “the apportionment process lies within the ATO process” implies JFACC ownership of both processes, which is emphatically not true. As Figure 3 shows, when one “zooms out” and adopts a more global view, it becomes clear that it is the JFC who makes the apportionment decisions and approves the target list. Although the JFACC and his staff are active participants, the JFC owns both processes.

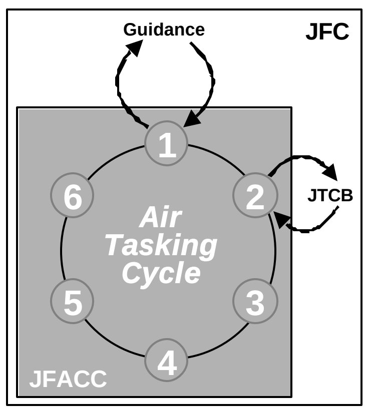

Figure 3: A More Global View of Process Ownership

Scope of the monograph

Joint and AF doctrine are quite clear on what apportionment is and whose responsibility it is. Lacking is any discussion of how it is accomplished. That is the angle from which this monograph approaches apportionment. It is not about targeting or the Joint Targeting Coordination Board (JTCB); it is not about what we strike or how that decision is made. It is about weight of effort and how we decide what to expend on each designated apportionment category. It does not restrict its discussion to joint or single-service issues. Since 1986 and passage of the Goldwater-Nichols Defense Reorganization Act the U.S. military services have constantly improved their ability to plan and work together: joint doctrine has matured. Substantial issues remain in the arena of combined air operations—both coalition and alliance. Many of these problems stem from technological advances and concomitant disparities. While a complete treatment of these challenges exceeds its scope, this monograph outlines several and points out where they impinge on the apportionment process. Finally, prior studies focused on the apportionment decision and its effects. They explicitly excluded process—both the ATO process and the apportionment process within it—thus ripping apportionment out of its context. This monograph is only tangentially concerned with the apportionment decision and its subsequent effect on the campaign or the enemy. It dwells on process.

HISTORICAL PERSPECTIVE

How Much History?

Doctrine is at least partially based upon history. To understand the origins of current apportionment processes, a brief historical review is useful. Unfortunately, the number of possible case studies is quite large. Robert Pape—an Assistant Professor of Government at Dartmouth College—cited thirty-three examples in his book <u>Bombing To Win</u>.[13] Shifting their focus to *joint* air operations and going back only as far as 1942, James Winnefeld and Dana Johnson reviewed six cases.[14] For this monograph, however, narrowing the field is simple. Since apportionment is not an issue in one-time strikes (such as the U.S. air strike into Libya in 1986), all such operations may be excluded from consideration. This is true for two reasons. First, rarely do such strikes have multiple objectives, so there is no need to apportion by objective. Second, such operations are relatively small, and a nation such as the United States rarely has a problem massing enough assets to accomplish all the tasks required to achieve the objective of the strike. Thus, apportioning by mission type is equally unnecessary.

Only major air campaigns remain for analysis—large-scale operations with multiple objectives where significant forces were utilized. The Korean War, the Vietnam War, and Operation Desert Storm provide adequate insight. World War II was excluded because it would provide marginal additional insight for the space required, although it must be noted that the mis-apportionment of airpower early in World War II is what solidified "centralized control" as the Air Force's prime tenet of airpower use. Also, much of the tension surrounding apportionment springs from the multi-role nature of modern aircraft, largely a consequence of technological advances. Although this quality of mission versatility was present in World War II, it was not the defining characteristic that it has become.

Korean War

In the Korean War there was no formal process for apportionment of U.S. air forces. Air operations during this conflict were characterized by service parochialism: functional component commanders and a coherent campaign plan were absent. Although ostensibly in charge of air operations in Korea, Lt. Gen. George Stratemeyer—the Far East Air Forces commander—was given only "coordination control" over naval air forces in the theater.[15] This term was created as a compromise between the Navy and Air Force, which differed widely in their views on the control, and often use, of air power. Its ambiguous definition resulted in neither command nor even tasking authority accruing to Gen. Stratemeyer, whose attempts at joint targeting were frustrated by his inability to even order anyone to show up at targeting meetings! Fragmented effort was thus the norm: even control of the Air Force fighter, fighter-bomber, and B-29 bombers was divided.[16]

In order to continue operations in this nearly coordination-free environment, the Navy carved out a chunk of North Korea for which it was responsible and within which it was, if not the sole operator, certainly the preponderant force provider.[17] This amounted to *de facto* geographical apportionment. There was no intentional weighting of effort in any service's sector. Rather, whatever number of sorties the Navy could generate on a given day went into the Navy's sector. So, too, with the Air Force. Often, the primary constraint was not number of available sorties—Winnefeld and Johnson noted that an "abundance of airpower" characterized U.S. operations in Korea—but rather lack of developed and approved targets. The challenges were joint operations and joint targeting.[18] The abundance of resources permitted operations without formal apportionment, either by making apportionment unnecessary or by masking its absence.

The only clear exception to this practice of apportionment by geography were air operations in support of United Nations (UN) ground forces penned in the Pusan perimeter. In this instance, the need was so serious, and the consequences of failure so grave, that it transcended service differences. During this period, there were two objectives ("defend the perimeter" and "establish conditions for a counteroffensive") which received nearly 100% of the effort. As desperation waned and UN forces gained the upper hand, this rudimentary apportionment by objective evolved into apportionment by mission type. Missions in direct support of ground forces, theater-level interdiction of North Korean lines of communication, and counterair operations were all conducted.[19] All forces of every service were involved, including Air Force strategic bombers.

The level of effort dedicated to supporting ground troops was highly contentious and remained a point of major disagreements between the Army and Air Force. For the first time this issue, now nearly a cliché, came to the fore. Moeller noted that "Army commanders felt Air Force leaders did not provide enough air support while air leaders felt the Army did not appreciate or understand the ability of airpower to influence the battlefield in ways other than the close-in battle" and, later, that the "ground force commander continually believed that Air Force was ignoring or stonewalling their airpower requests."[20]

Korea provides many insights into early efforts at apportionment. Initially, service parochialism was so strong that joint planning and operations were nearly impossible. Consequently, the only practical mode of operation was segregation of air forces by service. This amounted to apportionment by geography. Interservice differences were subsumed by the Pusan challenge, where the objective was obvious and urgent. Subsequent offensive operations saw the re-emergence of interservice debates about the control of air forces (primarily between the Air Force and the Navy) and about the level of direct support provided to the ground commander (between the Air Force and the Army). Throughout the war, target scarcity and plentiful resources averted the need for precise, formal apportionment. These are all recurring themes.

Vietnam War

Apportionment in Vietnam was much the same as apportionment in Korea, with the added dynamic of significant political control of military operations at all levels of war.[21] Chaotic apportionment was the unsurprising result.

Incompatible service doctrines again precluded substantive joint planning and execution. Throughout the war, each service controlled its own assets. The system's response to this self-induced "friction" was much the same as in Korea. Rather than attempting doctrinal reconciliation, the "route pack" concept—a much simpler expedient amounting to apportionment along geographic and service lines—was adopted. Dividing North Vietnam up into sectors and assigning them to individual services obviated the need for both coordination and substantive doctrinal discussions.

As in the Korean War, there were occasions in Vietnam when air forces were apportioned in other ways. Unlike Korea, however, the driving forces were not obvious military necessity, but rather an intermixing of political restrictions, lack of a coherent military campaign plan, and cumbersome, inefficient command chains. On 20 April 1965, the Secretary of Defense and "top regional commanders" set the air priorities for the remainder of the war at a high-level meeting in Honolulu, Hawaii. Winnefeld and Scott indicate that "in-country operations in support of U.S. and allied ground forces were to have priority over strikes into North Vietnam and Laos"[22] which appears to be apportionment by objective. However, according to Moeller, the order published by CINCPAC (Commander in Chief, Pacific) promulgating this guidance "made CAS the primary air mission in South Vietnam."[23] This reflects an emphasis on mission type (CAS) as opposed to objective ("support…ground forces"), and is also a narrower focus, since CAS is merely one type of support air forces can provide to ground forces.

Which of these views is correct is unimportant, although the lack of a campaign plan (which would contain the theater commander's objectives) favors Moeller's "mission-type" interpretation. Of greater consequence is the fact that this was not really *apportionment*, it was *prioritization*. The difference is significant. Both are important, but prioritization should merely be a step in the apportionment process, not replace it. That is what happened in Vietnam: apportionment was restricted to prioritization.

In Vietnam, these prioritization decisions masquerading as apportionment did not replace the route pack system as they did in the Korean War. Instead, the two systems coexisted. That is, each service provided as many sorties each day as it could and dedicated nearly all of them to ground troop support within its assigned area. This had the potential for tactical disaster. Route packs were developed precisely because interservice coordination was so difficult; it was thus unlikely that air forces would operate within another service's assigned area. As a result, support would be provided on the basis of sorties available from whichever service operated in that zone rather than according to the needs of the ground commander or the availability of resources theater-wide. Sorties from another service might well be available, yet go unused. This sort of inefficiency lies at the heart of the Air Force's advocacy of centralized control of air forces at the theater level.

Due to ill-defined responsibilities and chain of command, different headquarters assumed responsibility for different portions of the air war and they were often at odds with each other. CINCPAC's emphasis on CAS conflicted with airstrikes in the north, which were directed from Washington. At one time or another, both CINCPAC and COMUSMACV [Commander, United States Military Assistance Command, Vietnam] "tried their hands at designating targets and apportioning effort for the commander of the Seventh Air Force[, the air component commander,]…" who had almost no control over either process.[24] This essentially pitted tactical requirements against operational objectives within a system where nobody had the authority or expertise to arbitrate between them. Replacing the "coordination control" seen in the Korean War, CINCPAC granted 7th AF commander "mission control" over certain Marine aircraft. As in Korea, this vaguely defined concept solved nothing, and the Marines never relinquished control of any of their assets.[25]

Ironically, while there was no formal apportionment process, the target approval process was extremely rigid. It marched lock-step from Seventh Air Force and ground force commanders straight to the President for approval at the well-documented (and infamous) "Tuesday Lunch Meetings."[26] Fortunately, target scarcity was not the issue in Vietnam that it was in the Korean War. Target nominations were plentiful. Unfortunately, authority to strike them was retained at the highest level. This slowed the targeting system to a crawl. Thus, the flood of nominations produced only a dribble of approved targets.

Political restrictions profoundly affected all U.S. military operations in Vietnam. The U.S. feared escalation, both conventional (China entering the conflict) and nuclear. The restrictions manifested themselves at every level of war. The target approval scheme described above limited operations strategically. Forces based in Thailand were prohibited from attacking targets in South Vietnam because of a political decision made in Washington.[27] This constraint combined with CINCPAC's prioritization decision (which kept Vietnam-based air forces from attacking targets in

North Vietnam) to significantly restrict options at the operational level. Finally, concerns about the appearance of escalation as well as issues surrounding drawing down forces on nuclear alert delayed introduction of B-52s into the theater.[28] This had substantial tactical consequences as well as probable operational and strategic ramifications.

As in the Korean War, plentiful resources mitigated the effects of each of these problem areas. Doctrinal differences, political constraints, and command issues each acted to hinder the application of airpower. They decreased efficiency and precluded coherent campaign focus. Quantity masked these trends. Moeller pointed out that the nearly unconstrained number of available sorties resulted in ground commanders leaving Vietnam "with the belief that good air support meant dedicated sorties overhead, ready to attack targets immediately upon request."[29] The Honolulu-Saigon tension discussed above (different headquarters with different priorities and agendas) was similarly minimized. When air forces were dedicated to ground support missions and approved strikes into North Vietnam, what was left was available for other in-country operations. Winnefeld and Scott showed that "as it turned out, 'what was left' was in most cases more then enough."[30]

A less obvious current in this river of resources, however, deserves comment. The multi-role nature of aircraft began to emerge. F-4s flew dogfights, conducted CAS, and bombed bridges. B-52s flew in direct support of engaged troops, destroyed countless "suspected truck parks," mined Haiphong Harbor, and bombed dams. Single aircraft types were now being used in a variety of roles and accomplishing objectives at all levels of war. This versatility, along with increasingly small force structures, would soon emerge as the defining characteristics of airpower and provide powerful stimuli for the development of formal joint air apportionment processes.

Little pertaining to apportionment improved between the Korean War and the Vietnam War. Unwillingness to confront divergent service doctrine again resulted in segregation—geographic apportionment. From the tight political control emerged ambiguous command responsibilities, lack of operational-level campaign planning, and a slow, inflexible targeting system. There were attempts at apportionment along other than service lines, and there are indications that most command levels agreed upon the importance of apportionment (although not on who should do it or how). The majority of these problems were again masked by plentiful air assets, which again enabled an air campaign otherwise nearly paralyzed by self-induced friction. Not all was bleak, however. The utility of an overall air component commander and the utility of joint air operations were recognized; both concepts would soon be explored and, later, institutionalized. The Vietnam War continued trends in the United States' use of airpower that were not reversed until Operation Desert Storm.

Operation Desert Storm[31]

There were many improvements pertaining to apportionment between the Vietnam and Gulf Wars. The apportionment process was formalized, and the chains of command were far clearer in 1991 than in 1965. Some things were unchanged, however. For instance, fundamental interservice doctrinal issues remained intractable in spite of progress in the development of joint doctrine. Additionally, the United States' reliance on quantity to mask its doctrinal shortcomings held constant. Finally, Desert Storm hinted at new challenges.

Improvements in apportionment between the Vietnam War and the Gulf War stemmed from two basic sources: re-emphasis on the operational level of war, and formalization of joint doctrine. The single biggest step forward was a clear, explicit operational concept. Operation Desert Storm was conceived holistically from the outset, and the air plan that emerged was an objectives-based, unified campaign plan. While planners and leaders debated the objectives, their wording, and their prioritization, virtually all accepted the necessity of a linked, strategy-to-task architecture. Particularly noteworthy is that both sides of the targeting process were addressed from the very beginning: "what to strike" and "how much effort to expend striking it" were given appropriate, if not equal, attention.[32] Much of the success of Operation Desert Storm is attributable to the early intellectual energy invested in creating a logical and complete vision of the campaign shared by national leaders and commanders at every level.

Significant changes were seen in some traditional apportionment problem areas: clear chains of command with empowered component commanders, and (later in the war) formalization of the apportionment process. This was largely the result of the military's focus on "jointness," the second driving force of change between Vietnam and Desert Storm.[33] Component commanders were designated along functional lines rather than by service. Although the JFACC, Gen. Charles Horner, commanded 9th Air Force, he exercised tactical control (TACON) over some Navy and Marine air forces, as well as over SAC and Tomahawk Land Attack Missile (TLAM) operations.[34] TACON is "command authority over…military capability or forces made available for tasking, that is limited to the detailed and, usually, local direction and control of movements or maneuvers necessary to accomplish missions or tasks assigned."[35] It is a much clearer and thus more useful concept than both "coordination control" and "mission control." Command and control relationships among commanders and forces arrayed in Desert Storm were in every way better than those in Vietnam. Overall, functional component commanders were part of a simple, clear chain of command.[36]

The component commanders were also granted adequate authority and fairly wide autonomy to conduct their operations. These were not commanders in name, like the 7th Air Force Commander in Vietnam, but commanders in fact. Development of the attack plan for the first days of the air war—a huge effort—was directed by the JFACC and carried out by the Guidance Apportionment and Targeting (GAT) cell in the JFACC staff. Winnefeld and Scott found "little evidence that the CINC became involved in JFACC decisions other than those related to apportionment."[37] Nor was there much direct political involvement in the targeting process. Mann noted that "[b]efore execution—and for most of the forty-two days of the air war—decisions about targeting were made in the planning cell…Only after the Al Firdos bunker incident did high-level decision makers…intrude themselves by withholding most Baghdad targets."[38] In sum, Desert Storm was a textbook example of empowered commanders developing and executing their plans, a statement as true at the component level as at the theater level.

Process formalization was the second area of significant improvement. Although formed rather late in the process, the Joint Targeting Coordination Board (JTCB) became the focal point for all targeting and apportionment efforts in the theater and represents an unprecedented degree of formalization of the apportionment process. Several forces acted in concert towards its creation. Foremost among them was the contentious nature of the air campaign, and the continued deep distrust—primarily by ground commanders—of the Air Force. The prioritization of "strategic attack" targets over those supporting "battlefield preparation" was poorly understood and strongly resented. This, coupled with continuing interservice doctrinal friction (discussed below), gave rise to the other components' fundamental dissatisfaction with targeting. Too, as Taylor pointed out, "…the JFACC staff was overwhelmingly United States Air Force, which led Navy officials to believe they were not getting sufficient input in the targeting process."[39] Each of these issues made it more difficult for other services and components to participate in the apportionment process. It was not at all transparent.

The JTCB was created to address each of these concerns. The overall goal was for it to assume "greater control over the planning, apportionment, and allocation process for airpower employment"[40], making those processes much more responsive to ground commanders and the battlefield preparation plan. Although this "interference" reportedly angered many Air Force staff officers,[41] the JTCB remains a significant institutional lesson learned from Desert Storm and is embraced by all services. It facilitates joint targeting, allows components insight into the air apportionment process, creates a conduit for feedback, and provides a mechanism for their participation in order to prevent a recurrence of the "bad blood" so well documented in Desert Storm. Chains of command and formalization of the apportionment process are two examples of positive changes between the Vietnam War and the Gulf War.

Some things, however, were unchanged. Fundamental doctrinal issues remained as resistant to redress as ever. From a doctrinal standpoint, the central argument again broke down along service boundaries and revolved around the strategic air campaign and preparation of the battlefield for ground operations: "It was a quarrel over apportionment and timing."[42] Doctrinal debates with other services continued along similarly well-established lines. Both the Navy and Marine Corps were concerned that a too-powerful JFACC could siphon off their dedicated airpower, thus degrading those services' abilities to perform their own missions. However, enough Marine and Air Force resources were committed to Desert Storm to allow planners to avoid making a fundamental choice between indivisibility of the Marine Air-Ground Task Force and unity of control of airpower.[43] Mann summed it up: "…the interservice problems…might have been debilitating (or at least required a clearer resolution of authority) had it not been for the vast resources available to the coalition air forces."[44]

Plentiful resources still typified U.S. operations. In fact, resources affected the overall campaign design. Originally conceived as an air-only plan stressing strategic attack upon Iraqi centers of gravity, "Instant Thunder" explicitly intended to ignore fielded Iraqi forces in Kuwait.

General Schwarzkopf quickly broadened its focus to include the Republican Guard, and "…by the time the huge coalition air armada had assembled in the Middle East, it was neither prudent nor necessary to apply the whole weight of airpower to strategic attack. Yet, maintaining *sufficient* weight to achieve air campaign objectives remained extremely important."[45] Apportionment was a fundamental issue throughout the planning phase of Operation Desert Storm and remained so during execution.

The use of geographic apportionment is another historic problem area, like the doctrinal differences cited above, in which only marginal progress was made prior to Desert Storm. Overall, planners opted for more efficient, centralized control and deconfliction, so the use of route-packs was fairly restricted. In one case, zones were specified around Marine forces within which Marine commanders "retained control and tasking authority" of Marine fixed-wing tactical air forces.[46] This effectively segregated Marine air operations from the rest of the theater and was really yet another manifestation of doctrinal differences between the services. The segregation was not complete, however; Moeller found that the JFACC was called upon to reallocate sorties against Iraqi units in the Marines' sector.[47] Another example is the tightly controlled air operations in the vicinity of Baghdad. The only assets permitted to strike this sector were F-117s and cruise missiles. This is a form of geographic apportionment, but with a crucial difference. Here, forces were apportioned on the basis of their *capabilities* rather than by service or country. This marks the first time forces were apportioned in this manner, and reflects a step back from the current doctrinal touchstone of "effects-based targeting" to a more traditional input-based model.[48] Regardless of effects desired in downtown Baghdad, if only stealth and missiles were permitted to attack there, then the bombing stopped when stealth and missile assets were fully utilized. Geographic apportionment occurred less frequently in Desert Storm than in either of the two previous conflicts. Its character, however, changed radically and the consequences were significant.

Finally, Desert Storm hinted at some new challenges. One example is the wide use of precision guided munitions (PGMs) and cruise missiles. In his thesis, Anderson alluded to the apportionment challenges posed by PGMs by noting that "…some sorties were able to strike separate targets with multiple PGMs."[49] This hints that the paradigm of apportionment and allocation on a per-aircraft basis is threatened. Cruise missiles made their popular debut on CNN during the opening moments of hostilities, but they proved difficult to integrate. At the time, Air Force officers were unconvinced of TLAM's effectiveness and were reluctant to give it a major role.[50] Advances in technology and years of experience have removed all those doubts, which the Navy viewed as parochialism. The TLAM has become the weapon of choice in many instances (witness the term "Tomahawk diplomacy"). In spite of that, including missiles such as TLAMs, conventional air-launched cruise missiles (CALCMs) and Army Tactical Missile System (ATACMS) in the apportionment process remains a thoroughly unconventional and daunting task.

Another new challenge revolves around the introduction of the multi-role aircraft. Increasing complexity and sophistication come only at increasing cost, and in many instances capability replaced numbers. Aircraft such as the F-16 and the F-15E were billed as multi-role aircraft from the outset, and were purchased in far fewer numbers than air fleets before them. Increased concerns about force protection and preservation, coupled with the United States' transition from a "forward-based" to a "force projection" strategy, created apportionment decisions where none had existed before. Shortages of suppression of enemy air defenses (SEAD) and tanker resources forced those assets into a practical (though not CINC-driven) apportionment process, adding yet another degree of difficulty to an already imposing assignment.[51]

PGMs, cruise missiles, and multi-role aircraft all increase the complexity of the apportionment process and are examples of new trends introduced during Operation Desert Storm. Desert Storm also provides visible confirmation of other trends. Functional commanders, simple chains of command, and process formalization appear to be issues nearing resolution. On the other hand, significant doctrinal differences remain between the services and the United States' tendency to use resources to compensate for doctrinal or process deficiencies stayed constant. Finally, a new variation of geographic apportionment surfaced—one with serious apportionment consequences.

Summary

This section traced the evolution of the apportionment process through three major conflicts. Doctrinal disputes and resource proliferation emerged as two recurring themes. Weapons and weapons system advances are challenging traditional apportionment concepts. Also evident are the several functions of the apportionment decision. First, it is obviously an "order" in that it comprises the joint force commander's direction to the JFACC regarding the air campaign's weight of effort. Second, it is a coordination tool that enables better planning by all components by establishing levels of support from the JFACC. Finally, it can be a metric against which progress through the campaign can be measured. Apportionment should foster teamwork, not act against it. An open apportionment process helps create a cooperative planning environment, rather than an adversarial one.

The monograph next explores current doctrine on apportionment and examines recent NATO air operations over Kosovo. At its end, the totality of the background data will be sifted for characteristics which might typify an "ideal" apportionment process.

CURRENT DOCTRINE AND PRACTICES

Chicken or Egg?

Discussing Desert Storm in the historical review section rather than as a case study in present doctrine may raise some questions. The dividing line between "history" and "current practice" lies in the assertion that doctrinal evolution is iterative, not linear. From that viewpoint, joint doctrine preceded Desert Storm, yet was afterwards substantially changed by it. Thus the cause and effect relationship is so muddled that it is difficult to ascertain which came first. Actually, comparatively little was changed in mindset following Desert Storm, but much has changed in print. JP 3-56.1 was published in 1994. It institutionalized both the JFACC and JTCB concepts, which were relatively *ad hoc* in Desert Storm. General Zinni, a Marine and former commander of U.S. Central Command, noted that "'there is a lot of blood on the floor' from early interservice debates about the Joint Force Air Component Commander. 'Now, you hear nothing about JFACC. I don't hear any gripes or complaints or ... fears or lack of trust' from the other services that a single coordinator of airpower is anything but a sensible approach to organizing for war."[52] Similar changes have occurred throughout all services with respect to the JTCB, which is now a primary JFC-level forum for inter-component integration. Neither was the case in 1991: the JFACC concept was not widely accepted, nor was the JTCB institutionalized. That is why Desert Storm was "then" and Kosovo is "now."

Apportionment in current joint doctrine

Apportionment is the JFC's responsibility; it is an important tool he uses to coordinate the joint air effort with other parts of his campaign plan. The JFACC is the JFC's principal advisor on the operational use of airpower. After consulting with other component commanders, it is his responsibility to make an apportionment recommendation, based on the JFC's guidance and intent.[53] If the JFACC is an Air Force officer, the strategy division within his Joint Air Operations Center (JAOC) is the staff agency responsible for formulating the apportionment recommendation.[54] In cases where the JFC does not elect to organize functionally (that is, forces are organized by service), Air Force doctrine makes it the responsibility of the Commander of Air Force Forces (COMAFFOR) to make the recommendation.[55] During planning, the strategy division would make apportionment recommendations for each anticipated phase of the operation; during execution, it makes similar (though often more detailed) recommendations daily. These recommendations, once approved by the JFC, drive the ATO development and reflect the commander's most recent guidance.

This decision is made prior to the daily JTCB and is a significant item on the board's agenda, since apportionment establishes the framework within which the target list is developed. It would make little sense to create a list of mostly strategic attack targets when the JFC had apportioned only a small fraction of his effort for that mission type. The JTCB's primary responsibility is to ensure that the daily target list (the Joint Integrated Prioritized Target List, or JIPTL) includes targets clearly linked to the JFC's objectives, and that the list reflects his apportionment guidance.[56] The JTCB balances ends with means.

Having discussed current beliefs about how apportionment should be accomplished, and having some understanding of the forces that shaped those convictions, it is reasonable to ask how useful that doctrine has proven. Indications of usability may be seen in the degree to which doctrine was followed (or ignored) during recent NATO air operations in Kosovo. Bosnia is not studied because of its limited size and scope. The air force that took part in hostilities in Bosnia was comprised of about 290 aircraft from nine nations. "[In all,] some 3,515 sorties were flown delivering 1,026 weapons against forty-eight targets."[57] It was not really a campaign in the context of this monograph and posed no significant apportionment challenges.[58]

Operation Allied Force

There is some risk in attempting analysis of so recent an event. Most data remains classified, and ultimate effects and results are unclear and contentious. Too, a major caveat must be made. Apportionment in the past centered on how much of the air effort supported the ground effort. Leaving the ground component out of this fight certainly simplified the apportionment process. Nevertheless, NATO air operations over Kosovo and the Former Republic of Yugoslavia (FRY) provide some interesting data in the tracing of air apportionment concept development. First, the dominant theme of this conflict was the degree of political involvement in literally every facet of the planning and execution. For the purposes of this monograph, it manifested itself most strongly in two areas: in the target approval process, and in campaign design. Second, on the surface, the U.S. appears to have gone "big" again. Airpower resources were plentiful. In Kosovo, as in Vietnam and Korea, abundance masked problems. This time, however, the margin of excess was smaller, and the issues concealed were different.

The political constraints placed on military operations were pervasive and are well documented.[59] Limited domestic support (and thus shaky national will) in many of the member nations, as well as widely differing national interests, sharply bounded the feasible military options. In stark contrast were NATO's lofty goals: an end to repression in Kosovo, withdrawal of Serbian forces from the province, insertion of an international military presence, safe return of refugees, and willingness to work toward a political framework agreement.[60] Ends, ways, and means clashed from the outset; it is unsurprising that a sort of "lowest-common-denominator" strategy was employed, one that virtually guaranteed that every target would be scrutinized by each nation prior to approval.

Target approval was excruciatingly slow; target scarcity was the inescapable result. Some of the fault must be placed with the military. For the first half of the war, no doctrinally based targeting guidance and approval process was in place.[61] There was neither a GAT nor a JTCB. Rather, "target lists, instead of target sets based on desired effects against Serbian forces, were approved and disapproved spontaneously during daily VTCs [video teleconferences]" by General Wesley Clark, Supreme Allied Commander, Europe (SACEUR).[62] In an *ad hoc* process reminiscent of Vietnam, General Clark passed politically sensitive targets to the Joint Staff in the Pentagon for approval, which deferred to the Secretary of Defense and ultimately the President.[63] Note that in each case *individual* *targets* were considered. This was a significant departure from both joint and NATO doctrine, which advocate a macro-level approval process that deals in levels of detail no finer than target sets.[64] Furthermore, due to security concerns revolving around stealth technology, two daily ATOs were produced: one a U.S.-only product with stealth and cruise missile information listed on it, the other detailing remaining resources and releasable to NATO nations.[65] This further complicated an already confusing process.

By the end of the first week of Allied Force, the targeting process had nearly ground to a halt. Initially, the Master Target List had only 100 targets on it, only half of which were approved for strikes.[66] Already thus restricted, the implementation of increasingly stringent rules of engagement further reduced attacks on some target sets. After a "bombing accident" on 1 May in which Allied aircraft struck a bridge in Nis and inadvertently killed several civilians, General Mike Short, the Combined Force Air Component Commander (CFACC), recalled: "…the guidance for attacking bridges in the future was, you will no longer attack bridges in daylight; you will no longer attack bridges on weekends or market days or holidays; in fact, you will only attack bridges between 10:00 at night and 4:00 in the morning."[67] Incremental target approval from selective NATO nations was a chronic problem for operational planners.

The second area where the political nature of the conflict manifested itself was in campaign design. At the political level there never was a shared concept of the operation, although many had been proposed. Planners, whose efforts began in June 1998, eventually developed and produced forty different concepts before the fighting began.[68] Instead, lack of an approved campaign was driven by the "lowest common denominator" strategy alluded to above—gradual escalation—and was further complicated by several nations' belief that a short campaign using limited numbers of cruise missiles and air strikes could rapidly force Serbia to concede.[69] This "quick war syndrome" was also a factor in General Short's admitted tardiness in creating a GAT and instituting a JTCB, and General Clark's reluctance to fight for more than the initial fifty approved targets on the Master Target List.

With consensus and cohesion the driving forces, a three-phased air campaign was eventually settled upon (arguably more by default than design). Phase I involved NATO strikes on aircraft defenses and command bunkers, which (it was felt) would force the Serbian leadership to concede.

The concept was approved on 21 Aug 98 and labeled the "Limited Air Response."[70] Phase II began on 27 March 99 and extended the NATO strikes to the Serbian military infrastructure south of the 44th parallel. Phase III was to strike the Serbian capital in Belgrade if the Serbian leadership had not accepted NATO's terms. It was never authorized, because NATO leaders eventually realized that the constrained, gradual approach was ineffective.[71] On 23 April, they voted to expand the campaign, and SACEUR was authorized to "strike at additional targets…that were necessary to keep the pressure up, both on the tactical side in Kosovo and on the strategic side elsewhere in Yugoslavia."[72] A Chinese report summed up the concept:

> Attacks came from all directions, in all weather, and at all times of the day. Attacks escalated in three ways: in types of targets (from air defense and C2, to ground troops, to economic targets), in geographic region (from south of the 44th parallel to north of it), and in intensity (additional forces joined the attack after the first three days).[73]

The concept had some apportionment ramifications. Phase I involved almost no apportionment, as all effort was directed at the objective of air superiority. There was little competition for resources on the basis of either region or objective. Also, the level of effort early in the conflict was quite low (reflecting the "quick war syndrome"); additional requirements could have been easily handled by the size force then available. In Phase II operations were explicitly limited geographically. The target sets expanded somewhat to encompass interdiction targets and fielded forces, and NATO dedicated approximately thirty percent of its sorties to striking Serbian forces during this phase.[74] It was clearly General Clark's intent to apportion by objective (attacking fielded forces in and around Kosovo supported the objectives of "end repression" and "Serbian withdrawal") during this phase, and not by mission type or aircraft type. When NATO authorized expanding the campaign, Belgrade (and areas north of it) came under attack. This is the area where collateral damage issues were highest, political sensitivities were at their maximum, and precision was required. This newfound operational freedom allowed General Short to reshuffle resources and missions. First, he said, "I was able to release much of the force that had been employed in Kosovo to go after other target sets in the Belgrade area, north of Belgrade, Novi Sad, Nis, et cetera." More importantly, though, he "was able to use what he termed the 'more high-tech' airplanes for targets better suited to their abilities in Serbia while retaining the 'lower-tech' airplanes…against Serb forces in Kosovo. Up until that time, the only sorties being flown outside Kosovo were by U.S.-only types of assets, such as the F-117 fighter and B-2 bomber."[75]

On one level, this is just common sense: assigning the right aircraft to the right mission in light of the threat environment. In another sense, it amounts to geographical apportionment. Perpetuating a trend that began with restriction of strike sorties over Baghdad to F-117s and cruise missiles, apportionment based on weapon system capabilities was this time a dominant theme of the expanded campaign. The results were similar in both cases. Maximum effort in the most important region of the area of operations was dictated by a very small fraction of the force.

As it turned out, the "very small fraction" of a very large number meant there were adequate assets available to achieve desired effects throughout the war, although the margin was quite slim in several areas. Stockpiles of several key weapons dipped quite low.[76] Many aircraft in the U.S. fleet were stretched thin. Airlift and tanker forces were taxed, especially with the impending retirement of the C-141. EA-6B Prowlers—the United States' sole jammer aircraft—had to redeploy from CENTCOM, and F-16CJ training "stopped completely during the campaign." F-16s and F-15Es are suffering from structural wear, lack of engines, and deferred training. In general, the spare parts concept, designed for a single, violent war rather than a drawn out series of lengthy operations, was inadequate as well.[77] The United States was again able to operate in an environment largely unconstrained by resources, but just barely.

As before, asset availability hid some problems. In Kosovo, however, the problems were new and centered on the high tech/low tech disparity and increasing reliance on PGMs. There were some early process issues, but they were eventually addressed. Operation Allied Force is important to a discussion of the usability of joint apportionment doctrine—and a fitting cap to the review of operational examples—because it clearly illustrates the difficulties of efficiently apportioning new capabilities, both extant and emerging. The apportionment decision was equally useful as a coordination tool between air forces of different nations as between components within the JTF. Political constraints were once again primary considerations in a large-scale military operation (many believe that this will become the norm), historical methods of apportionment continued to be challenged by new weapons, and the United States' traditional reliance on large force structure to cover doctrinal or procedural shortcomings appears in jeopardy.[78] Disturbingly, though, these issues persisted in spite of the lack of a ground component, in what intuitively should have been a less challenging apportionment environment.

STANDARDS AND CRITERIA DEVELOPMENT

The primary purpose of the monograph is to explore the effects that emerging capabilities and technologies might have on the apportionment process. To accomplish this, it is necessary to have some sense of the characteristics of an ideal apportionment process, which the foregoing review was intended to illuminate. This best-case baseline is important—even though it has yet to be realized operationally—because if the ideal system proves unable to fully embrace these new technologies, then the prospect is dim for any sub-optimal process where the effects of any conceptual deficiencies would be magnified.

Three characteristics of an ideal apportionment process are proposed as a result of the preceding analysis. First, the process must be *efficient*. A good process wastes little time, facilitates quick accomplishment of its tasks, and ideally lends itself to automation so it can be incorporated into present or future battle management software suites. Second, such a process must be *complete*. That is, each relevant capability must be identified, apportioned, and utilized. For instance, in Operation Allied Force, it would have made little sense to apportion by aircraft type. Since several o nations flew F-16s, which varied widely in capability (ranging from day, visual air-to-air capable only, to night capable PGM droppers, to those specially suited to SEAD with anti-radiation missiles), that apportionment category would have been useless. Finally, *transparency* sees the apportionment process as a communication tool and requires that the entire process be visible and understandable to each relevant actor (staff officers from different components and representatives from other nations' air forces, for instance). To facilitate this, the apportionment decision must be presented as clearly and simply as possible. This may be the central issue, as a poorly worded or communicated decision would render the most efficient, complete and transparent process meaningless.

These criteria give rise to a series of questions that must be asked in each area of investigation. First, *what are the effects of technology on apportionment*? Second, *are those effects* *incorporated into current apportionment processes*? *At what cost*? If they are incorporated, the entire process might take longer (it costs time); conversely, if they are not incorporated, there is increased risk of data loss at the least, more probably un- or mis-used capabilities and resources.

The answers to these questions will be combined in the final section. There, answers to the question, "*How might the process be fixed*?" will yield conclusions and recommendations.

Forces of Change

Separating wheat from chaff

Figure 4 sums up the analysis so far. In the left column are all the issues mentioned in the previous section. The Xs show those conflicts in which each issue arose. It is quite a lengthy list, and the matrix does little to clarify. However, graphing these trends on a set of axes similar to those in Figure 5 helps. The picture is still cluttered, but patterns become evident. In fact, each of the ten issues in Figure 4 follows one of the four curves (or profiles) shown in Figure 5. It should be stressed that the graph is not intended as an exact, absolute measure: the data types vary widely and in some cases are not subject to measurement.

Issue	Korea	Vietnam	Gulf	Kosovo	Profile
Joint Operations	x	x	x	x	1
Doctrinal Differences	x	x	x	x	
Route Packs	x	x	x	x	2
Resource Availability	x	x	x	x	3
Multirole Aircraft		x	x	x	
Missiles			x	x	
PGMs		x	x	x	
Campaign Concept		x	x	x	4
Political Involvement	x	x	x	x	
Target Approval Process		x		x	

Figure 4: Issue Matrix

The correlation is not precise, but conceptual; only a “broad brush” mapping is sought. The curve for each issue is shown in the last column on the right in Figure 4. By employing this reductionist methodology, it is hoped that the ten issues can be distilled into a more manageable number**.**

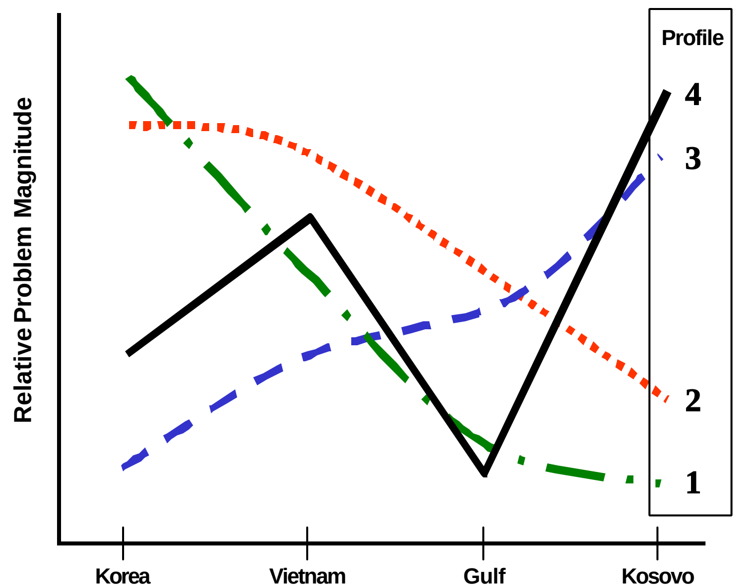

Figure 5: Simplified Issue Profiles

Profile one, for instance, illustrates the substantial decline of *jointness* as a problem area. An unambiguous example of progress in this area is the functional air component commander. Absent in Korea, named but unempowered in Vietnam, implemented with difficulty (but great success) in Operation Desert Storm, and accepted without comment in Operation Allied Force, this is clearly a problem on its way to solution. Most other joint airpower employment issues follow suit. There are certainly still substantive doctrinal differences between each of the services on the control and employment of airpower, but they are gradually being addressed and solved.

Profile two traces the similar demise of the route pack concept. Its shape is reasonable, since geographic segregation of air forces <u>based on service</u> reflects the status of joint warfighting doctrine. Route packs are no longer the only way to fight. Instead, they are a tool that can be used intelligently in instances where there are no better choices. Its use will probably never drop to zero, but it has ceased to be a problem vis-à-vis apportionment.

Profile three reflects the long-standing trend toward smaller U.S. force structure (*resource availability*). This process has accelerated dramatically since the Gulf War and shows little sign of slowing. Conventional wisdom holds that the effects of this trend are offset by an increasing reliance on technology. That means that in theory a "technology" curve and a "force structure" curve would interact to form an "X," with the net combat power remaining constant (picture an X with a bar over it). Since *multi-role* aircraft intuitively reflects technology (in much the same way *route packs* followed *jointness*), one would expect *multi-role* to move **opposite** to the force structure curve in Figure 5: *multi-role* would more properly be associated with Profile two and generally decrease over time. That would be true if the vertical axis in Figure 5 measured <u>capability</u>. Instead, what it shows is <u>magnitude of challenge</u> posed to the apportionment process. Sophisticated aircraft capable of multiple mission types or tasks make apportionment harder—especially when there are fewer of them than there would be of less expensive aircraft. Declining *force structure* and increasing sophistication (reflected in *multi-role* capability) are both gradually complicating the apportionment process.

Missiles and *PGMs* also mirror this profile, although PGMs did not appear in significant numbers until Vietnam, and missiles were not an issue prior to Operation Desert Storm. Nevertheless, once they start, they both demonstrate the same increasing and accelerating behavior as the *technology/force structure* duo.

Profile four is much more dramatic—and worrisome—because of the direction and magnitude of its final leg. *Political involvement*, *target approval* process, and *campaign concept* all swing wildly from conflict to conflict. Common sense points out that where national interests are significant and objectives are clear, problems are fewer. For example, in Vietnam and Kosovo (characterized by high levels of ambiguity) the curve is at its maximum; in Desert Storm (where national interests were significant and clearly presented) the relative magnitude of the problems drops off. Profile four is most problematic because it shows no trend. There is no way to predict its future behavior because the issues it characterizes are all highly situational. More importantly, while they all affect apportionment in very fundamental ways (the campaign concept structures the process, while target approval governs the urgency and fidelity with which it must be carried out), they are all higher-order problems that the apportionment process can do little to accommodate. These are in the "too hard" box; continued pursuit will gain nothing.

Having declined to consider Profile four, and having noted that Profiles one and two issues seem on their way to solution, one is left with only those four issues embedded in Profile three. Note that *resource availability*, like the Profile four problems, is a higher order constraint that should have more bearing on allocation—translating apportionment decisions into numbers of sorties—than it should on apportionment. There is nothing the air planner needs to do to adapt his process to a smaller force.

After that final iteration, two problems remain: advances in weapons systems (the multirole concept, stealth, and General Short's "high tech/low tech" dichotomy), and advances in weapons (PGMs and cruise missiles). The dividing line is not always crystal clear, nor is it important. What is important is that an *efficient* and *complete* apportionment process must encompass and accommodate them all. These two areas are potentially what Senge calls "leverage points." These are places within a system where "small, well-focused actions can sometimes produce significant, enduring improvements."[79] Since apportionment may be viewed as a system within the ATO production process (itself part of many higher-order systems), the potential for relatively small procedural changes to measurably expand operational capability is very real.

Technological advances in weapons systems

The advent of stealth technology and the increased presence of multi-role aircraft on the battlefield are two areas in which advances in aircraft design have dramatic apportionment consequences. Stealth is the most significant. Most attention is paid to reduced radar signature, but stealth is actually a "set of technologies that reduces the observable signature of aircraft not just in terms of radar cross section, but in all other observable phenomena: visual, infrared (heat), acoustic (sound), and electromagnetic (e.g., radio)."[80] The principles are pervasive, and applications are being found on helicopters and naval ships with impressive results.[81] The added capabilities stealth provides are well documented. Stealth aircraft can operate autonomously to a much greater degree than non-stealthy aircraft, a potent advantage. Supporting traditional strike packages is a very complex and delicate operation. Breakdowns in wartime are inevitable—Clausewitz's friction of war intrudes everywhere[82]—and can be catastrophic. Stealth lowers the consequences of temporary breakdowns in complex systems and can facilitate plans that are simpler and more flexible.

Security issues surround stealth, and it is here that apportionment feels the first hint of friction. The close-hold nature of every facet of stealth aircraft operations forces apportionment to be opaque: exactly the opposite of the *transparent* ideal. *Efficiency* and *completeness* were thus tremendously hampered. In Operation Allied Force, the "dual-ATO process" exemplified this notion. There, all "U.S.-only" assets (stealth aircraft and cruise missiles) were published on a separate ATO available only to American personnel.[83] Several "near misses" resulted from NATO forces not having visibility into <u>all</u> operations: aircraft flew and appeared to aimlessly orbit (untasked yet unavailable for tasking), or aircraft appeared in places (or at times) where they were not expected. The potential for fratricide was significant. The disadvantage of this type of apportionment by capability—geographic segregation of stealth resources from other strikes—became evident in both Desert Storm and Allied Force. In each case stealth aircraft were such a small fraction of the total force that the coalition's striking power against the capitol cities was severely restricted.

Apportionment by capability reflects a clear preference for *completeness* over *efficiency*. From an operational perspective, this is the best choice (especially if efficiency pertains to the planning process). This decision is sustainable as long as either the level of effort is relatively low or the number of "special cases"—stealth platforms—that must be handled individually remains small. Early in Allied Force, the level of effort was certainly low, and the number of stealth aircraft participating in both wars was quite small (forty-two F-117s were deployed for Desert Storm, twelve to Allied force; and in the whole of Allied Force, B-2s only flew approximately seventy sorties).[84] When the special cases bog down the process, however, and risk delaying ATO production, the benefits of *completeness* may wane and the need for *efficiency* reassert itself. As stealth assets become more mainstream, security concerns will hopefully become less imperative, and much of this problem will fix itself.

The second friction point between apportionment and advances in aircraft technology lies in the area of multi-role capability. Fifty years ago, no aircraft was designed from the outset this characteristic in mind.[85] Today, there are several aircraft worldwide so designed, with the F-15E

Strike Eagle being perhaps the most outstanding example. These aircraft can perform a wide variety of missions, often able to assume more than one role in one sortie. The Strike Eagle is equally at home in the air-to-ground role as it is in the air-to-air environment, and may be given interdiction, offensive or defensive counterair, or even strategic attack missions. Such aircraft are far more versatile than their single-mission counterparts, and are useful in a far greater number of scenarios. They are also much more flexible—often changing mission or target literally "on the fly"—and add flexibility to the planning process too.

Multi-role aircraft challenge apportionment in the areas of *efficiency* and *transparency*. The degree to which they complicate the process depends entirely upon how assets are apportioned in a given theater or conflict. Apportioning by aircraft type or by mission type requires a second, underlying "accounting" process to ensure that the same aircraft is not unwittingly committed to being two places (or doing two things) at the same time. Yet these jets <u>can</u> do two tasks on the same mission, and accounting for that can result in the apparent impossibility of planning to use in excess of 100% of available assets. Tracking this data severely degrades *efficiency*. Also, *transparency* is reduced, since providing a simple, clear explanation of an apportionment total of 106% is nearly impossible. One fix is to apportion by objective or task instead of mission type or aircraft type. The first step would be to fill apportionment categories with single-role aircraft types, then "fill in the cracks" with the more versatile planes. When needs exceed that total (when 100% is not enough), then consider "swinging" multi-role aircraft into secondary functions on same sortie. This would have to be done manually.

Each of these—particularly stealth—is actually a portion of a larger problem faced by air planners. It is captured in the "have/have-not", or "high tech/low tech" disparity to which General Short alluded. The disparities in capabilities can be significant in a coalition force. Nations provide fighter aircraft that either are or are not able to drop PGMs. These same aircraft may be air-refuelable, have sophisticated electronic interrogation devices that can separate friend from foe, be night capable, and have secure communications capability, or they may not. Currently, the most important of these characteristics is PGM delivery capability. In the near future, however, the defining capability may be the ability to receive, process, display, and use real-time in-flight data updates about weather, threats, or targets. Several trial programs are underway in the United States to equip some aircraft with this capability.

To address this problem, the desire to apportion by capability is overwhelming. However, this resurrects the apparent overutilization problem: since these capabilities are not exclusive of each other, apportionment totals could exceed 100%. The same aircraft, for instance, would be in both the "night capable" and "PGM capable" apportionment categories. Apportioning by category would work if the number of critical categories could be reduced to one. Otherwise, the best way to approach the problem is via brute force: apportion by aircraft type, with a number of sub-categories created where required. The F-16, for instance, is flown by the air forces in over twenty nations and comes in many variations with widely differing capabilities.[86] In this case, the process would provide for *complete* apportionment, but at severe cost to the other two criteria.

The two topics discussed above do not form an exhaustive list of ways in which new weapon systems affect apportionment. They are illustrative, however, of the realities of modern coalition war. Stealth will remain the purview of the United States for the foreseeable future, force structure limitations ensure multi-role aircraft have a secure future, and the worldwide technological disparities will probably continue to grow. A process must be created that can adapt to these situations, or face the risk grossly sub-optimal employment with its ensuing costs in blood, treasure, and prestige.

Technological advances in weapons

The monograph now turns to the effect of new weapons on apportionment. Two pertinent advances in weapons technology are improved precision (that is, precision guided munitions), and increased standoff capability characterized by cruise missiles. The line between the two is blurred somewhat by a class of weapons with precision accuracy that can be delivered a sufficient distance away from their target to improve the survivability of their delivery platform.

Precision guided munitions are not new. Debuting in the Vietnam, their continued improvement in accuracy, affordability, and usability has been phenomenal. Culminating these advances is the Joint Direct Attack Munition. JDAM is a GPS-aided munition intended to "drastically but cost-effectively improve free fall bombing accuracy."[87] A new tail section with an attached guidance system is fitted to old 2,000 pound Mk-84 bombs, newer BLU-109s (penetrating weapons designed for use against hardened targets), and 1,000 pound class Mk-83s (primarily for future use by the F-22). Immediately prior to release, the guidance system receives aircraft position, velocity, and (most importantly) target location from the aircraft's navigation system. When dropped, the weapon guides itself to the target based on GPS data received while in flight. JDAM represents a significant advance in capability over other PGMs because it is truly an all-weather weapon which requires no special equipment aircraft systems (such as a laser designator) for its employment.

PGMs are in demand. In the Vietnam War, less than one percent of all air-delivered weapons were PGMs.[88] This increased to nine percent in the Gulf War. About half of these—4.3 percent—were laser-guided bombs, which caused approximately seventy-five percent of the serious damage inflicted upon Iraqi strategic and operational targets.[89] In Kosovo, use of PGMs quadrupled to thirty-five percent, of which 650 were JDAM. Most telling, between 24 March and 24 April fully ninety percent of the bombs and missiles used were PGMs due to bad weather. Only seven of the first twenty-one days of the war were "favorable;" at least fifty percent of the strike sorties had to be cancelled on an additional ten days.[90] This highlights how heavily dependent laser guided munitions are on good weather, and the huge increase in capability provided by JDAM and other radar or inertial navigation equipped weapons. It also explains why nearly every bomb-dropping aircraft in the U.S. inventory is to be certified to carry and release JDAM. About seventy percent of the planned 60,000 JDAMs will go to the heavy bomber fleet, which will "be able to accurately deliver conventional weapons from high altitudes regardless of weather conditions."[91]

The most significant change wrought by PGMs also poses the biggest challenge to the apportionment process. Precision guided munitions have reversed the traditional ratio of "multiple sorties per target" to "multiple targets per sortie." This is a substantial change, one not precisely captured by the current process. In Desert Storm, F-117s typically struck two targets per sortie, and F-111Fs often struck multiple aimpoints each time they flew.[92] In Kosovo, each B-2 was capable of dropping sixteen JDAMs against sixteen different targets. When the B-1B finishes its certification process, its capacity will be twenty-four weapons.[93] Tirpak reported that the next generation of PGMs will emphasize "…miniaturization to enable more kills per sortie; and increased accuracy to ensure destruction with a smaller weapon and to minimize the chances for collateral damage."[94] Obviously, the trend will continue upward, and twenty-four bombs per aircraft is only a temporary maximum. These numbers have huge apportionment implications. The currency of today's apportionment process is *aircraft*. Where each aircraft is paired with one target, the current process efficiently and completely covers taskings—that is how it was designed.

When the ratio is reversed, however, the process become much more difficult. Where one aircraft can strike twenty-four different targets, one is quickly forced into apportioning fractions of aircraft and the result is much the same as in the multi-role discussion above. Where all the weapons from a jet are to be dropped on the same target, there is no problem. Similarly, as long as all of the targets for that aircraft fall within the same apportionment category—even if they are not the same target complex or even in the same geographic area—the fractions are aggregated under the same category heading and are thus "transparent." In both cases the problem is masked. When the same aircraft is tasked to bomb targets from several categories (perhaps a bridge, an airfield, and a headquarters building), the problem becomes obvious: one must either accept dealing with fractions or sacrifice some degree of accuracy (i.e., completeness).

There are two possible solutions. First, one could accept the requirement for "special handling" inherent in those assets that must be apportioned fractionally and opt to apportion by capability, much as was discussed earlier with stealth. The challenge remains unchanged: this course of action is sustainable only as long as the level of effort is low, or the number of assets requiring this level of attention—this much time—is small. While in Kosovo this was the case, it will not be for long. In Kosovo, only the B-2 dropped JDAMs. Eventually, twelve aircraft types will drop them, including the F-16 and F/A-18, which are among the most numerous in the inventory.[95] This decision favoring completeness over efficiency is conceptually the simplest, is operationally preferable to sub-optimizing the force, but is least sustainable in the long term. Completeness is achieved in spite of the formal system, not because of it.

Another option is to apportion by weapon rather than aircraft; that is, treat individual bombs as aircraft are treated now. The approach is appealing. Fractions disappear, and it may prove easier to meter the use of these valuable weapons of limited availability. As the weapons become more prevalent, and the number of aircraft able to use them proliferates, this advantage would slowly fade.

While it is true that apportioning this way would multiply the apportionment problem by sixteen or twenty-four, this is a brute-force problem easily handled with computers. Additionally, that objection really speaks to allocation, which would undoubtedly be complicated by implementing this solution. This option, like the one discussed above, also favors completeness but not at the expense of efficiency. Since the entire process would have to be changed, both characteristics could be expected. Transparency is also facilitated in this case (relative to the first option), as the concept is easily explained and conveyed. However, this solution will have some significant system-wide effects throughout the ATO process that are difficult to predict and assess. Not least among them is the possible restricting of weaponeering choices, and the much more significant problem of essentially combining the apportionment, allocation, and attack planning steps into one. Apportioning weapons rather than aircraft is a very attractive alternative when contemplated strictly from a very local viewpoint. When one "zooms out," though, to a system-wide focus, the upheavals it entails make it considerably less appealing. Precision guided munitions pose a formidable obstacle to efficient, complete, and transparent apportionment.

The transition between a discussion about precision bombs and one about missiles with significant standoff capability is blurred by several weapons that straddle the line: ones with precision accuracy that can be delivered a distance away from their target sufficient to improve the survivability of their delivery platform. The Joint Stand Off Weapons (JSOW) and the Joint Air to Surface Standoff Missile (JASSM) are examples. JSOW is an unpowered glide weapon with a range of fifteen to forty nautical miles (depending on launch altitude). It is a GPS-aided "launch and leave" weapon capable of day/night and adverse weather operations, which is both reprogrammable and retargetable in flight.[96] Like the JDAM, it will be carried by nearly all bomb-dropping platforms in the inventory. JASSM is a precision cruise missile designed for launch from outside area defenses to kill hard, medium-hardened, soft, and area type targets. Its range is approximately sixty nautical miles and, like the JSOW, navigates by a GPS-aided inertial navigation. These PGMs pose all of the same apportionment challenges as those discussed above. By expanding the number of targets held at risk by aircraft in the US inventory, they further increase the problems' complexity.

Cruise missiles have forced changes in the apportionment process equally as significant as those caused by precision bombs. Cruise missiles have been around for quite a while and their proliferation has been explosive. As of 1995, Zaloga reported, "about 75,000 cruise missile of 130 types and manufactured by nineteen different countries had already been exported to seventy-five countries." [97] Proponents contend that, like stealth, cruise missiles eliminate the need for a support package during deep strikes. Actually, missiles are even more attractive in that role since they eliminate the need, not just for support sorties, but the bomber sortie as well. Furthermore, since aircrews are not placed at risk, anticipated political gains are not held hostage to the capture or death of a pilot. These facts, in many minds, place stealth and standoff in direct competition.

The past nine years have made it clear that cruise missiles are no longer viewed as a limited-use strategic weapon. 282 cruise missiles were used in Operation Desert Storm, fifty-two on the first night.[98] 850 cruise missiles have been used since Operation Desert Storm in Iraq, the Balkans, Sudan, and Afghanistan—including 330 used in Operation Desert Fox and 329 in Operation Allied Force.[99] "Tomahawk diplomacy" has generated waves worldwide: Russia is considering exporting cruise missiles, Israel would like to acquire Tomahawks "as a possible compensation from the US for strategic withdrawal from the Golan heights as part of a U.S.-brokered peace deal with Syria," the United Kingdom has decided to proceed with development of its Conventionally Armed Stand-Off Missile, and France is pushing ahead with its stealthy cruise missile, reported as "virtually radar transparent, including from AWACS."[100]

Missiles pose different apportionment challenges than those posed by other weapons. First, they are not often even included in the process, probably because apportionment deals with aircraft, not missiles. There is no other barrier than this conceptual one, as missiles would easily fit into a changed system where weapons were apportioned. Perhaps to some degree the exclusion is a vestige of service parochialism. Regardless of the reason, omission of cruise missiles from the apportionment process threatens its completeness and may have efficiency implications. Transition to apportionment by weapons (or just inclusion of missiles in the current process) would address both issues and might have additional transparency benefits, since individual weapons would handled earlier in the targeting process and their proposed use would be more visible to every component.

The second apportionment challenge missiles pose was touched upon in the last section. Security concerns surround cruise missile technology much as they do stealth. Again, the "dual ATO" system exemplifies the difficulties in integrating sensitive national capabilities into a coalition operation. The fragmented command and control issues are difficult enough to handle, but if <u>several</u> countries were to act similarly—holding part of their force in reserve, acting ostensibly in concert with (but separate from) other coalition operations—the entire process could unravel. The potential for redundant strikes or overlooked targets would skyrocket. In densely populated airspace, such independent operations could also substantially increase the risk of fratricide, which centralized control has held to nearly zero in recent conflicts. Such a fragmented non-process would be dangerously inefficient and could be hopelessly incomplete; by its very nature it would be only moderately transparent. As long as cruise missile technology is a closely held national secret, this problem is insoluble. There is hope, however. All technologies and weapons eventually become "mainstream." Continued worldwide proliferation and advances in missile technology will accelerate this process.

The final issue surrounding apportionment of missiles is their nature as a constrained resource. Obvious as it sounds, missiles and bombs do not return to base to be apportioned again tomorrow. Although large, stocks of cruise missiles are unquestionably finite. Bender reported that stocks of CALCMs and JDAM were reduced to less than 100 by the Kosovo conflict, which was of too short a duration to allow for much additional production. Stocks of cruise missiles will never be as large as desired. Nor are cruise missiles the only missiles present on today's battlefield. The Army's Tactical Missile System (ATACMS), the Navy's Standoff Land Attack Missile (SLAM and—with extended range—SLAM ER), and the Air Force's AGM-142 Have Nap and AGM-130 all face similar issues. In the interim, these weapons remain very valuable assets of limited availability that would probably benefit from inclusion in the formal apportionment process.

GPS-aided bombs and cruise missiles have helped change the face of airpower. The operational advantages they bring of increased precision and lethality with lower risk to aircrew and less collateral damage are accompanied by obstacles to their efficient and complete integration into the ATO process. Although they are assuming a continually increasing share of targeting taskings, it must be noted that they are only two tools among many. As Huber wrote: "Precision direct attack for nonstealth aircraft (very permissive environment) and stealth aircraft (non-permissive environment) are the economically appropriate weapons in any scenario with a high volume of precision targets."[101] The ATO process has to function at any point on the conflict spectrum, from one-time strikes (where apportionment is not even considered) to major theater war (where apportionment may be a driving issue). Consequently, a way must be found to incorporate each of these capabilities—and foreseeable additional ones—into that process. The system must make use of all resources provided to the JFC completely, efficiently, and transparently.

ANALYSIS

Introduction

In this section all of the problems highlighted in the last section are consolidated and grouped under the three apportionment process characteristics. Many of the problems, even though they spring from different causes, are similar. Aggregating them based on their shared nature will allow the large list to be distilled to a much smaller one—the reductionist at work again. Similar problems should prove amenable to the same solution, and those will be presented next. Unfortunately, the ATO process is a very complex system, and solutions that address apportionment woes may—when considered in a broader context—prove inadequate or actually counterproductive.

Problems of Completeness

Earlier, completeness was defined as the ability to identify, apportion, and utilize each relevant capability of available joint or multinational air forces. Completeness emphasizes execution rather than planning and stresses optimum use of resources. It is the primary challenge posed by multi-role aircraft, since even capturing the data about dual-mission tasked aircraft is often impossible or not attempted. Completeness is also a secondary problem presented by stealth bombers—actually by all heavy bombers—since they carry so many PGMs and can strike targets from several target sets (and so strike in multiple mission types or in support of several objectives). In the case of the B-2, this challenge is mitigated by the fact that there are so few aircraft that no choice need be made between manual tracking or none at all. Manual tracking is easy.

The most basic problem cruise missiles have is merely that of inclusion in the apportionment process. Indirectly, this is a completeness question: how can the 100% level be determined if all assets are not counted, but injected into the process later? As was pointed out earlier, one would much rather have a complete process than an efficient one, if a choice had to be made; operational concerns should always trump planning considerations where possible. Commanders have historically made exactly that choice several times. As long as the number of cruise missiles stays fairly low, manual tracking is feasible, and this choice is supportable. Unfortunately, cruise missile use has increased dramatically, and shows every sign of continuing that trend. That means that choosing completeness over efficiency may not remain feasible for long.

Problems of Efficiency

In contrast to completeness, efficiency measures how well apportionment facilitates planning. An efficient process wastes little time, facilitates quick accomplishment of its tasks, and ideally lends itself to automation for incorporation into battle management software suites. The primary challenge posed by PGMs is one of efficiency. Completeness is not really a problem: each weapon is dropped on a target, and the nature of the target usually determines the apportionment category that bomb falls into. As long as apportionment deals with aircraft, and several weapons can drop off an aircraft against several targets, however, "fractions" of aircraft really attack targets. Managing these fractions is the efficiency challenge. Coalition technological disparities also bring primarily efficiency challenges, which can vary in significance depending on the availability of a few binary criteria to which the entire force can be held.

Stealth assets are still "silver bullets" that get special handling, so there are some efficiency concerns: such operations cost time. Similarly, the additional time and effort required to track fractions and manage dual taskings when dealing with multi-role capable aircraft implies an efficiency penalty. Cruise missiles, on the other hand, would present no efficiency problems if included. Each missile could be considered a sortie and each sortie would attack a target. That is exactly what the system is designed to handle. If future concepts become reality, and individual missiles become able to attack more than one target, this would no longer be the case. Cruise missiles would then pose exactly the same challenges as PGMs.

Considerable time has been spent on the difficulties incurred by dealing in “fractions” of aircraft, which stem from two problem areas: PGM use and multi-role aircraft. Multi-role fractions come from aircraft straddling mission-type lines (where the same jet conducts SA then DCA missions, for instance). PGM fractions, however, come from aircraft straddling objectives or tasks—not mission types. For instance, an aircraft could attack targets supporting three different objectives on one sortie. It could help “reduce NCA’s ability to command and control 3rd Army” by attacking a national communications facility. It could then attack a radar site, thus “reducing enemy ability to defend Capitolville from air attack.” Its final target, a bridge, would assist the JFACC in “slowing enemy reinforcement of 3rd Army by fourty-eight hours.” If the JFC apportioned by objective, capturing these fractions poses a challenge. Maddeningly, these problems require opposite fixes. Apportioning by objective makes the multi-role problem practically go away, but it maximizes PGM problems. Conversely, apportioning by mission type helps reduce PGM fractions, but is the very source of difficulty in the multi-role sphere.

Completeness and efficiency are in tension. The fact is inescapable that completeness (counting every bean and making sure it is placed in the best pile) takes time, while efficiency (counting beans, but wasting neither time nor effort) flinches at every tick of the clock. Planning cycles will continue to shorten as modern warriors continually seek to get inside their adversary’s decision loop. Time will become scarcer and efficient processes more valuable. There may come a time when it is not possible to favor completeness over efficiency to as great a degree as today.

Problems of Transparency

Transparency views the apportionment process as a communication tool and requires that the entire process be visible and understandable to each relevant actor. Consequently, transparency is concerned with the format of the apportionment decision, which must be presented as clearly, simply, and completely as possible. The security concerns that surround stealth, largely shared by cruise missiles, are the source of its most significant apportionment challenge. Segregating these assets (like the U.S. did in Kosovo with the “U.S.-only ATO”) create—almost by definition—a non-transparent apportionment process. Spillover into the other two criteria areas is unavoidable. Such a system will be incomplete (a sub-optimal plan is executed because information is not shared) and inefficient (the special handling required for each "secret" asset take time). Limited inventories and the monopoly on stealth keep these penalties admittedly small for now. The main point is that the basis for these inefficiencies lies not in the nature of the weapons themselves, but are inherent in the transparency challenges created by how they are used. Stealth aircraft and cruise missiles are not elegantly included in a coalition ATO process.

The transparency concerns that multi-role aircraft engender are different. They revolve around clarity and simplicity in the apportionment decision. Multiple categories and sub-categories, totals that exceed 100%, fractions of aircraft—these do not contribute to simplicity and clarity. Again, a poorly worded or communicated decision would render the best process meaningless.

What To Do?

No fewer than fifteen solutions are suggested throughout this monograph, ranging from "do nothing" to "apportioning by weapon," a complete change of paradigm which entails significant redesign of the entire ATO process (a cure that might be worse than the disease). Fortunately, all these proposals may be reduced to five. These are "tactical" answers; each addresses one small niche (transparency issues posed by PGMs, for instance) with little regard for additional consequences. From a systems standpoint, though, an "operational" answer (or combination of solutions)—one that improved the entire apportionment process—is preferable. Ideal would be a "strategic" solution which improved and shortened the overall ATO process. Apportionment is a fairly simple process; the system within which it fits is emphatically not. On the contrary, the ATO process exhibits dynamic complexity. Senge described dynamic complexity as a system in which the "same action has dramatically different effects in the short run and the long…when an action has one set of consequences locally and a very different set of consequences in another part of the system…when obvious interventions produce nonobvious consequences."[102] Close attention must be paid to the various system levels as proposed solutions are discussed.

The first option is to do nothing. The various requirements for manual intervention, added explanation, additional sub-categories, special handling, and managing assorted fractions and percentages might just be accepted. The multi-role, high tech/low tech disparity, and PGM problems would all be controlled or managed. With minimal effort, cruise missiles could be added to the process, although the resulting gains would be equally minimal. “Mainstreaming,” a variation on the do nothing theme, has also been discussed. Arguably, both stealth and cruise missiles would benefit from this approach. The concept is to wait for the inevitable transition from “silver bullet” to “just another weapon.” Cruise missiles appear to be well on their way in this respect. Doing nothing is, of course, the easiest response in the short term, as doctrinal concepts, hardware, and (in many cases) workarounds already exist. It implicitly accepts inefficiency in favor of completeness. Transparency issues remain problematic and unaddressed. The most significant weakness of this option, however, is the underlying assumption that the inefficiencies and workarounds will remain viable in the future. This appears unlikely. Cruise missiles will continue to proliferate and our own stocks will be replenished. JDAM certification will continue across the Air Force and Navy, and stocks of that weapon will swell. Ongoing upgrades of the B-2 fleet will make more of them increasingly capable. These are important trends that threaten the validity of that assumption. Even the very cursory look at PGM use made earlier, from one percent in Vietnam, to nine percent in Operation Desert Storm to thirty-five percent in Operation Allied Force makes it highly suspect. Doing nothing may answer in the short term. Its long-term prospects are not appealing.

The second option is to apportion by capability. This seems to be the most obvious fix for stealth, but there are costs. Stealth aircraft form a small percentage of the force. Consequently, the effects they can generate are limited by availability. This fact was observed in both Desert Storm and Kosovo. Apportioning by capability might help the high tech/low tech disparity if the situation allows identification of a small set of binary criteria for categories and sub-categories. For instance, groups of PGM-capable, or not PGM-capable. Within the PGM group could be sub-categories of stealth or non-stealth. In the absence of such a criteria set, the objections of apportioning by capability to handle the coalition disparity reduce to substantially the same as for multi-role: capabilities are not necessarily mutually exclusive and might lead to totals greater than 100%. Additionally, PGM-capable aircraft may not <u>always</u> employ PGMs. This is a weaponeering decision that must be made on a target by target basis. Apportionment by capability seems to offer little other than limited “tactical” effects. It only addresses two of the six problem areas, and actually worsens one (multi-role). It may help in combination with others, but it is clearly not the hoped-for Sengeian “lever.”

Option three is much more promising. Apportioning by objective is a simple change from the more traditional apportioning by mission type. It solves the multi-role problem completely, fixes most of the coalition disparity problem, gracefully incorporates cruise missiles, and reduces the special handling requirements for stealth. The biggest drawback is that the PGM problem is maximized. That might be reduced if this option was combined with elements of the next choice (apportioning weapons instead of aircraft). The biggest gains that this solution makes are in transparency. The apportionment decision is vastly more useful and clearer if airpower is measured directly against agreed-upon endstates, shared among all commanders and published for use by all planners. Apportioning by objective is conceptually simple, easy to implement, and elegantly addresses most of the "tactical" problems with no obvious adverse consequences.

The most extreme possibility, option four, involves switching from considering aircraft during apportionment to considering individual weapons. This has several advantages. It is very transparent, it eliminates the requirement to handle fractions, and it would gracefully incorporate cruise missiles. While it will multiply all the apportionment numbers, it does not increase the conceptual difficulty, and tracking large numbers is something a computer can do quite well. This system would be very complete and transparent, and probably could be made fairly efficient. It would operate quite smoothly at moderate levels of PGM use, but might not be robust enough to grow at the same phenomenal rate that PGM use has. Although theoretically appealing, this option requires extensive system revamping and has substantial systemic consequences whose effects cannot be anticipated. It is not a realistic alternative.

There is some middle ground in the choice between apportioning aircraft and apportioning weapons. Perhaps the aircraft paradigm could be retained with selective weapons added on, such as cruise missiles, JDAM, JASSM and JSOW. This, in conjunction with apportionment by objective, shows great promise. All of the advantages of option three would be retained, while its glaring drawback would be substantially reduced.

The final option is a collection of proposals that might be labeled "miscellaneous artificialities." They amount to self-induced restrictions on airpower use in attempts to minimize or mask apportionment friction. All involve reduced transparency and, almost by definition, sub-optimal execution. All are purely “tactical” answers with limited utility and are not discussed further.

There are two additional insights which, although not rooted in advances in weapons technology, will help improve the apportionment process itself: they are “operational” level proposals. The first deals with the apportionment decision. Figure 1 of the monograph showed several “challenges to clarity” with respect to this important decision. They fall into three areas: what to count (bombing sorties, ATO lines, maximum sortie generation capability, for example), how to count it (by priority, by percentage, or by weight of effort), and how it is categorized (geographically, by mission type, or by objective). The historical review illustrated that each of these approaches has been tried with widely variable success. These three questions must be answered prior to beginning any operational apportionment, or the results will be confusing and perhaps meaningless or incorrect.

Much can be simplified if commanders phrase their apportionment decisions in weights of effort rather than strict percentages. If they are relatively loosely defined (notionally, “high” weight of effort might be defined as “in excess of thirty percent of the effort”, while “low” would be “less than five percent”, with “medium” spanning the two). There are several advantages. First, almost all discussion of fractions could be dispensed with since they would doubtless not added up to something greater than the latitude allowed by the definitions. Second, it allows planners some “slop” in the planning process to account for geographic distribution of targets, or to take advantage of proximity or packaging to attack additional targets. Finally, empowering planners to make decisions within sharply defined boundaries removes the necessity for their constant interaction with the commander. Frequent fine-tuning of the apportionment decision as planning increases in detail during the ATO production process can soak up a big chunk of the commander’s time. There is a slight possible objection: while the latitude inherent in weight of effort is good for planners, it is less attractive to other components which may wish to use the apportionment decision as a “report card” to gage how closely the JFACC complied with the JFC’s guidance and how that guidance translated into progress at the campaign level. In response, iIt should be stressed that very precise apportionment data will still be available—to the tenth of a percentile, if desired—during and after execution. Following publication of the ATO, sorties can be broken out and subtotaled in any fashion desired to measure compliance. Similarly, after execution, adequate historical records are kept to facilitate the critical task of assessment. Expressing apportionment decisions in weights of effort empowers subordinates by delegating the authority to use well defined "wiggle room" in apportionment. Improved operational art, more free time for the commander, and a faster ATO process are some of the possible results.

The second suggestion is simpler. Battle management software should be modified to facilitate exactly those data extraction and formatting functions discussed above. This has already occurred, as within the last few months the Air Force fielded its new Theater Battle Management Core Systems (TBMCS) software. Being able to easily extract and create these totals increases both efficiency and transparency in the apportionment process and facilitates combat assessment. Both of these suggestions are at least at the "operational" level—improving the apportionment process—and may have "strategic" effects on the overarching ATO process, too.

CONCLUSION

Air apportionment is the JFC's tool for weighting the main and supporting efforts within the JFACC's supporting air operations. It complements the targeting process by specifying how much effort is to be expended on strikes within each apportionment category, thus it comprises much of the operational art of airpower employment at the theater level. Many apportionment methods have been tried since World War II. Rapid advances in weapons technology have accompanied the evolution of the apportionment process and continue to shape it. This monograph has identified several areas of friction between the two, and proposed some solutions that should minimize the discord, if taken together and assessed from a systems viewpoint. More importantly, they would substantively increase the efficiency and transparency of the apportionment process without sacrificing any completeness. They should help the ATO process generate a qualitatively better product.

"Unified action" is the essence of joint operations.[103] Apportionment is a critical part of the effort to integrate and synchronize operations of joint forces in order to produce unity of effort. Apportionment is already a complex process, and the advances in weapons and weapons technology presented in this monograph all further complicate it. The challenges are significant now. Continued technological improvements, coupled with continued downsizing of force structure, threaten to create a paradoxical situation in which command and control processes—apportionment among them—are particularly ill-equipped to operate, yet where the urgency for precise and efficient force application is historically high. Changes need to be initiated now; command and control systems must grow at the same rate as the weapons and systems they manage. The risks are costly inefficiencies and perhaps even mission failure.

RECOMMENDATIONS

Several recommendations can be made. It must be noted, however, that substantial, lasting change will only result from long-term commitment to each of these suggestions. Fixing any one of these—taking the expedient route—merely "shifts the burden" to another part of the system.

First, much hinges on the phrasing of the apportionment decision. It is a true leverage point. **Commanders should phrase their apportion decisions using weight of effort**.

Second, **commanders should apportion their forces based on theater or component objectives or tasks**. Apportioning geographically, by mission type, and by capability have all been tried and shown wanting. Apportionment by objective is simple, transparent, and very efficient. Objectives would continue to be determined during deliberate or crisis action planning by the JFC as he designs his campaign, or subordinate commanders as they create their supporting plans.

Third, consideration should be given to experimentation to assess how practical and useful it would be to **apportion by weapon for certain weapons**.

Finally, **battle management software must facilitate extraction of data relevant to apportionment**.

ENDNOTES

[1] U.S. Department of the Air Force, Air Force Doctrine Document 1, Air Force Basic Doctrine (Maxwell AFB, AL: Headquarters Air Force Doctrine Center, 1 September 1997), 23. Joint doctrine phrases it centralized *planning* and decentralized execution, adding "Centralized planning is essential for controlling and coordinating the efforts of all available forces." See U.S. Joint Staff, Joint Pub 3-56.1, Command and Control for Joint Air Operations (Washington, DC: Government Printing Office, 14 November 1994), I-2.

[2] Robert D. Walz, "The Joint Strategic Planning System; the Planning, Programming and Budgeting System; And the Joint Operational Planning and Execution System," [Online] available at http://www-cgsc.army.mil/ djco/core/m500/2000/lsn03/ ln3rdb.doc, p.4.
[3] U.S. Joint Staff, JP 4-0, Doctrine for Logistic Support of Joint Operations (Washington, DC: Government Printing Office, 27 January 1995), II-6.
[4] U.S. Joint Staff, Joint Pub 3-56.1, IV-7. "Versatility" alludes to airpower's ability to perform many different functions; "flexibility" is its ability to rapidly shift from one function to another.
[5] U.S. Joint Staff, Joint Pub 3-56.1, IV-7.
[6] U.S. Joint Staff, Joint Pub 3-56.1, IV-7.
[7] "Air campaign" is not a doctrinal term. In fact, there is only one campaign: the Joint Force Commander's joint campaign. For simplicity, however, the term "air campaign" will be used to refer to the joint air operations conducted by the JFACC in support of the JFC's joint campaign.
[8] E. West Anderson, Calming All Their Fears: An Analysis of Expressing the Apportionment Decision (Maxwell Air Force Base, AL: Air University Press, 1998), 2.
[9] U.S. Joint Staff, JP1-02, Department of Defense Dictionary of Military and Associated Terms (Washington, DC: Government Printing Office, 23 March 1994 amended through 10 January 2000), 27.
[10] U.S. Joint Staff, Joint Pub 3-0, Doctrine for Joint Operations (Washington, D.C.: Government Printing Office, 1 February 1995), III-27.
[11] The Warfare Studies Institute phrases it: "Here[, when deciding priority,] you must decide if a given target is important enough to delay attacking other targets, or even delay the start of another phase, until you've achieved the desired effects. In some cases, limited resources may force you to move on when the allocated level of effort has been expended against less important targets, regardless of the effects achieved. Tasks with high associated levels of effort will probably be the determining factors in your phase transition decisions." Warfare Studies Institute, Air Campaign Planning Handbook (Maxwell Air Force Base, AL: College of Aerospace Doctrine, Research, and Education, March 2000), 35.
[12] Specifically, Operation Desert Storm (discussed later). See Winnefeld and Johnson, Anderson, Moeller for discussions of the interservice friction and its genesis.
[13] Robert A. Pape, Bombing to Win: Airpower and Coercion in War (New York: Cornell University Press, 1996), 48.
[14] James A. Winnefield and Dana J. Johnson, Joint Air Operations: Pursuit of Unity in Command and Control, 1942-1991 (Maryland: Naval Institute Press, 1993), 2.
[15] Winnefeld and Johnson, 42.
[16] David Taylor, Let History Help...But Not Too Much: Effectively Using the JTCB (Newport, RI: Naval War College, 1997), 3.
[17] Taylor, 3.
[18] Winnefeld and Johnson, 54.
[19] Current U.S. Air Force doctrine groups close air support (CAS) and air interdiction (AI) under the "counterland" function. The two are distinguished by the timing of when the effects will be felt (the effects of CAS are immediate, whereas AI may take days to be felt) and degree of coordination required (CAS, by definition, is in close proximity to friendly troops and required close coordination with them; AI is not and does not). AI is further broken down into direct-support interdiction (those operations directly supporting the Land Component Commander) and theater interdiction, which support the Joint Force Commander's interdiction objectives. See U.S. Department of the Air Force, Air Force Doctrine Document 2-1.3, Counterland (Maxwell AFB, AL: Headquarters Air Force Doctrine Center, 27 August 1999), Chapter 1.
[20] Michael R. Moeller, The Sum of Their Fears: The relationship between the Joint Targeting Coordination Board and the Joint Force Commander (Maxwell Air Force Base, AL: Air University Press, 1995), 8.
[21] Winnefeld and Johnson, 63.
[22] Winnefeld and Johnson, 6.
[23] Moeller, 12.
[24] Winnefeld and Johnson, 77 and 145.
[25] Winnefeld and Johnson, 73.
[26] See Winnefeld and Johnson, 75, for a step-by-step trip through the target approval process. For a discussion of the Tuesday Lunch Meetings, see H.R. McMaster, Dereliction of Duty: Lyndon Johnson, Robert McNamara, the Joint Chiefs of Staff, and the lies that led to Vietnam (New York: HarperCollins Publishers, 1997),88-89 and 329.

[27] Winnefeld and Johnson, 68.
[28] B-52s were used in "direct support of ground troops for the first time in the defense of the Plei Me camp near Pleiku, South Vietnam, in November 1965." The staff had been working to get them committed since the Honolulu conference on 20 April. Winnefeld and Johnson, 74.
[29] Moeller, 12.
[30] Winnefeld and Johnson, 77.
[31] No targeting or apportionment processes were in place for Operation Desert Shield, since it was essentially the pre-hostilities phase of conflict. All planning conducted before 17 January 1991 (the day air combat operations began) was for Operation Desert Storm and the apportionment process discussion applies only to that portion of the campaign.
[32] Richard T. Reynolds, Heart of the Storm: The Genesis of the Air Campaign against Iraq (Maxwell AFB, AL: Air University Press, 1995), 122 Footnote 26. "Warden…talked about Instant Thunder's commitment of 35-40 percent of coalition forces to the destruction of Iraqi aircraft on the ground." And on pg. 123: "'What percentage of the effort is being used to eliminate [Saddam Hussein]?' Horner asked.
[33] In the 1986 Goldwater-Nichols Defense Reorganization Act, Congress increased the relative importance of the regional CINC (at the expense of the military services) and joint warfighting became the touchstone concept for a wave of changes that included formalization of joint doctrine, emphasis on joint systems development and integration, increased joint education at every level, and frequent large-scale joint exercises. The geneses of this act were several failed or less than successful military operations that shared lack of joint integration as a contributing factor.
[34] Winnefeld and Johnson, 109.
[35] U.S. Joint Staff, JP1-02, 442.
[36] The only exception to this is the fact that the CINC also acted as the JFLCC. This had significant operational ramifications. The CINC, acting as the JFLCC, often interacted directly with the JFACC. Thus, an important coordination step and communication opportunity was frequently lost and ground commanders were rarely provided the rationale behind targeting and apportionment decisions. Actually, resentment was not restricted to ground commanders, but was occasionally shared by naval commanders, as well. See Taylor, 5-6; Moeller, 14; and Winnefeld and Johnson, 125 for examples.
[37] Winnefeld and Johnson, 105 and 111.
[38] Edward C. Mann III, Thunder and Lightning: Desert Storm and the Airpower Debates (Maxwell AFB, AL: Air University Press, 1995), 157.
[39] Taylor, 5.
[40] Moeller, 19.
[41] Winnefeld and Johnson, 125 and Taylor, 6.
[42] Winnefeld and Johnson, 120.
[43] Winnefeld and Johnson, 133.
[44] Mann, 80.
[45] Mann, 65.
[46] Winnefeld and Johnson, 119.
[47] Moeller, 15.
[48] "Input-based" models focus on number of aircraft, sorties, ordnance delivered, or (in this case) type of aircraft used in strikes, rather than the effects those sorties and weapons generate. See Warfare Studies Institute, 6.
[49] Anderson, 51.
[50] Winnefeld and Johnson, 132.
[51] Winnefeld and Johnson, 123. This process is not discussed further in the monograph, as it involves support, not combat, airpower.
[52] Quoted in John A. Tirpak, "Kosovo Retrospective: USAF leaders and others tell more of the story behind the Allied Force campaign," Air Force Magazine 83 no. 4 (April 2000) from 1999 Air Warfare Symposium, sponsored by the Air Force Association, where he spoke about "expectations for airpower from a JTF commander's point of view."
[53] U.S. Joint Staff, Joint Pub 3-56.1, IV-3.
[54] Several theaters have a team within the strategy division that deals exclusively with issues surrounding the JTCB, such as target nomination lists and apportionment. This team is called the Guidance Apportionment and Targeting (GAT) team. Whereas the remainder of the strategy division (which includes the combat assessment function) has a phase or campaign perspective, the GAT team is intimately involved in the JIPTL and

apportionment recommendations for each ATO, a much nearer-term focus. Prior to publication of AFDD-2, the GAT was broken out in most JAOC "wiring diagrams" as a separate division. Although the function has been subsumed into the strategy division, the team continues to exist in some AOCs.

[55] U.S. Department of the Air Force, Air Force Doctrine Document 2, *Organization and Employment of Aerospace Power* (Maxwell AFB, AL: Headquarters Air Force Doctrine Center. 28 September 1998), 47.

[56] The JFC designates the role of the JTCB. In some cases, the JTCB itself develops the target list; in other cases it serves more of an oversight function (JP 3-56.1, pg IV-2). Several interesting papers have been written on the utility and proposed functions of a centralized targeting board. See Moeller, Taylor, and Jonathan B. Hunter, Joint Operational Targeting: Who's in Charge; CINC, JFACC, or JTCB? (Fort Leavenworth, KS: U.S. Army Command and General Staff College, May 1994), for instance.

[57] Peter W. Gray, "Air Operations for Strategic Effect—theory and practice in Kosovo," Royal Air Force Air Power Review 3 no. 1 (Spring 2000), 23.

[58] Some authors would disagree. See, for instance, Robert C. Owen, ed., Deliberate force : a case study in effective air campaigning. Final report of the Air University Balkans air campaign study (Maxwell AFB, AL : Air University Press, 2000).

[59] See Cordesman, 50; Tirpak, Short's View; Friedman, 6. For detailed treatment of Kosovo and its implications, see Michael Ignatieff, Virtual War (New York: Henry Hold and Company, 2000), 161-215.

[60] North Atlantic Treaty Organization Press Release M-NAC-1(99)51, "The situation in and around Kosovo: Statement Issued at the Extraordinary Ministerial Meeting of the North Atlantic Council" (Brussels, Belgium: 12 April 1999), [Online] available at: http://www.NATO.int/docu/pr/1999/p99-051e.htm.

[61] Paul C. Strickland, "USAF Aerospace-Power Doctrine: Decisive or Coercive?" Aerospace Power Journal Vol. XIV, No. 2 (Fall 2000), [Online] available at http://www.airpower.maxwell.af.mil/airchronicles/apj/apj00/fal00/strickland.htm.

[62] Strickland.

[63] Daniel L. Byman and Matthew C. Waxman, "Kosovo and the Great Air Power Debate," International Security 24 no. 4 (Spring 2000), 33.

[64] General Short, the Combined Forces Air Component Commander (CFACC) for Operation Allied Force, felt strongly about this. In his testimony before the Senate Armed Services Committee after the war, he said "I believe, however, Admiral Ellis [the JTF commander] and I should have been given target categories from which we could choose at the tactical and operational level, and been given the ability to go after that target set as we saw fit with the assets made available to U.S. to bring them down." "Senate Armed Services Committee Holds a Hearing on The Lessons Learned From The Air Campaign In Kosovo" (Washington, D.C.: Federal Document Clearing House, 21 Oct 99), 24.

[65] Tirpak, "Kosovo Retrospective," and Strickland.

[66] Strickland.

[67] Senate Armed Services Committee Hearing, 26.

[68] Anthony H. Cordesman, The Lessons and Non-Lessons of the Air and Missile War in Kosovo (Washington, D.C.: Center for Strategic and International Studies, revised 20 July 1999), 6 and Strickland.

[69] Cordesman, 7.

[70] Federation of American Scientists, "Operation Allied Force, Operation Noble Anvil," [Online] available at: http://www.fas.org/man/dod-101/ops/allied_force.htm.

[71] Federation of American Scientists, "Operation Allied Force, Operation Noble Anvil."

[72] Federation of American Scientists, "Operation Allied Force, Operation Noble Anvil."

[73] Zhang Zhaozhong, in "Discussion of the Kosovo Crisis among Experts at the National Defense University," *Jiefangjun Bao* (Beijing), 13 April 1999 quoted in James D. Perry, "Operation Allied Force: The View from Beijing," Aerospace Power Journal no. 2 (Summer 2000), [Online] available at http://www.airpower.maxwell.af.mil/airchronicles/apj/apj00/sum00/perry.htm.

[74] Byman and Waxman, 22.

[75] John A. Tirpak, "Short's View of the Air Campaign," Air Force Magazine 82 no. 9 (September 1999), [Online] available at http://www.afa.org/magazine/watch/0999watch.html

[76] AGM-86 CALCMs (Conventional, Air Launched Cruise Missiles), and GBU-30 and –31 JDAM (Joint Direct Attack Munition) bombs were down to stocks of 100 or less; AGM-130 missiles, and GBU-10 and –12 laser-guided bombs had to be sourced from other CINCs' stocks. Bryan Bender, "US weapons shortages risked success in Kosovo," Jane's Defense Weekly 32 no. 14 (October 6, 1999), 3.

[77] Bill Sweetman, "Lessons of Kosovo: USA—learning the hard way," Interavia 54 no. 634 (September 1999), 41 and 42. Bender, 3. And Norman Friedman, "Was Kosovo the Future?" U.S. Naval Institute Proceedings 126 no. 1 (January 2000), 6.
[78] Kosovo is not helpful in amplifying the ongoing interservice doctrinal debates regarding use and control of airpower, except to the extent that discussion surrounding Task Force Hawk (well beyond the scope of this monograph) may eventually be useful in that respect.
[79] Peter M. Senge, The Fifth Discipline: the Art And Practice Of The Learning Organization (New York: Currency Doubleday, 1990), 64.
[80] Christopher J. Bowie, "The stealth revolution in aerial combat," Air Power History 45 no. 4 (Winter 1998), 11.
[81] Nick Cook, "The Disappearing Helicopter," Jane's Defense Weekly 32 no. 4 (28 July 1999) and Kenneth S. Brower, "Stealth and surface combatants," Naval Forces 19 no. 4 (1998). The most significant ship design challenges are reducing ships' wakes, minimizing cavitation caused by propellers, and shrinking the Vee-shaped bow wave, which newer radars can detect. The mission for stealthy helicopter design is making it quiet. "Active blade control" is an emerging technology that may cut noise by as much as 70%.
[82] No SAMS monograph would be complete without at least one reference to Carl von Clausewitz.
[83] Strickland
[84] Bowie, 14 and Kenneth Freeman, "Assessing cost effectiveness: The B-2 in conventional missions," RUSI Journal 144 no. 6 (December 1999), 38.
[85] Nick Cook, "Data and stealth key to air attack," International Defense Review 28 no. 11 (November 1995), 48.
[86] "F-16 Fighting Falcon Factsheet," [Online] available at http://www.lockheedmartin.com/factsheets/product16_hi.html
[87] Joris Janssen-Lok, "Doubts remain over GPS for JDAM," Jane's Defense Weekly 21 no. 24 (18 June 1994), 46.
[88] Robert J. Bunker, "Bombs, Smart (PGMs)," in Encyclopedia of the Vietnam War, ed. Spencer C. Tucker, (Santa Barbara, CA: ABC-CLIO, 1998), 75.
[89] Richard P. Hallion, Air Power Studies Centre Paper Number 53: Precision Guided Munitions and the New Era of Warfare, [Online] available at http://www.fas.org/man/dod-101/sys/smart/docs/paper53.htm#GULF.
[90] Cordesman, 5.
[91] John A. Tirpak, "With Stealth in the Balkans," Air Force Magazine 82 no. 10 (October 1999); Bender, 3; and Freeman, 38. Cordesman, 4 and 5. And Janssen-Lok, 47.
[92] Bowie, 15 and Anderson, footnote 108.
[93] Air Armament Center, pg. 5-13.
[94] Tirpak, "With Stealth in the Balkans."
[95] Janssen-Lok, 47 and Bowie, 14.
[96] Don Herskovitz, "Of JDAM, JASSM and JSOW," Journal of Electronic Defense 22 no. 7 (July 1999) and Federation of American Scientists, "AGM-154A Joint Standoff Weapon (JSOW)," [Online] available at http://www.fas.org/man/dod-101/sys/smart/agm-154.htm.
[97] Steven J. Zaloga, "The cruise missile threat: Exaggerated or premature?" Jane's Intelligence Review 12 no. 4 (April 2000), 47 for Egyptian ALCM use. Proliferation facts on page 48.
[98] Bowie, 14 and Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey Summary Report (Washington, D.C.: U.S. Government Printing Office, 1993), 184.
[99] Zaloga, 48 and Cordesman, 5.
[100] Zaloga, 50-51; Cook, "Data and stealth key to air attack," 51; and Jean-Paul Philippe, "Matra to develop APTGD missile: a new 'stealth' cruise missile for France," Military Technology 19 no. 2 (February 1995), 61.
[101] Jeff Huber, "Cruise Missiles of the Gods," U.S. Naval Institute Proceedings 123 no. 7 (July 1997), 31.
[102] Senge, 71.
[103] U.S. Joint Staff, Joint Pub 0-2, Unified Action Armed Forces (UNAAF) (Washington, DC: Government Printing Office, 24 February 1995), I-4 to I-5.

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